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VOLUNTARY SERVICES IN THE MODERN STATE

TO his earlier reports on social insurance and full employment, Lord Beveridge has now added a third, entitled "Voluntary Action"*. In the first of these reports Lord Beveridge emphasized that social security must be achieved by co-operation between the State and the individual, and that in organising security for service and contribution, the State should not stifle incentive, opportunity or responsibility. In establishing a national minimum, he urged, the State should leave room and provide encouragement for voluntary action by each individual to provide more than that minimum for himself and his family. A scheme run by the State, in other words, is not enough.

This third report is something more than a corollary or complement to the first two. Indeed, it could well be argued that, both logically and historically, it should have preceded both the report on social security and that on full employment. Like its predecessors, its main emphasis is on duty, either of the community, that is to say, its leaders, or of the individual. "Emphasis on duty rather than assertion of rights," writes Lord Beveridge, "presents itself to-day as the condition on which alone humanity can resume the progress in civilization which has been interrupted by two world wars and remains halted by their consequences."

These words give the clue to the essence of the third report. Far more than a call to action, it is a challenge to thought. Its implications run far beyond the activities of the institutions immediately surveyed into the whole web of social and cultural activity that makes up the pattern of Western civilization as we know it to-day. "Voluntary Action" is both an outspoken defence of human freedom and a plea for the creative thought, out of which alone can emerge the new institutions we need to-day to safeguard our heritage and ensure the free expression of human personality. Lord Beveridge's inquiry was conducted primarily at the instigation of a leading 'friendly society'; and although the first part of his book is concerned essentially with the work of such societies, he did not limit his inquiry to that field. Even in that section of the book, there are comments that are relevant in a much wider context; and in the main the recommendations for action and the eight-point programme for the State with which he concludes, apart from the suggested Friendly Societies Act and the rectifying of the position of the housing societies—which, as he observes, at present receive from the Government warm words and cold comfort—have implications affecting the whole field of voluntary action.

The making of a good society, Lord Beveridge reminds us, depends not on the State but on the citizens, acting individually or in free association with one another, acting on motives of various kinds—some selfish, others unselfish, some narrow and material, others inspired by love of man and love of

* Voluntary Action: a Report on Methods of Social Advance. By Lord Beveridge. Pp. 420. (London: George Allen and Unwin, Ltd. 1948.) 16s. net.

God. The happiness or unhappiness of the society in which we live depends upon ourselves as citizens, not on the instrument of political power which we call the State. This present report is designed especially to show some of the tasks which must be undertaken, if prosperity, when it comes, is to mean the chance of happiness for all. It is a challenge to the men and women of a free society to make, and keep, something other than the pursuit of gain as the dominant force in society.

Lord Beveridge recognizes frankly that, with the passage from class rule to representative democracy, little can be done except by influencing directly, not a few leaders, but the mass of the people. He believes that the spirit of service is in the people of Britain, but that only in the few is it a driving force which makes them pioneers, not to be stayed by difficulties. There is always need for the few—for dynamic individuals wholly possessed by this spirit. In one brilliant chapter Lord Beveridge displays vividly the way in which such pioneers call forth the same spirit in others, leading by example and creating the institutions and societies through which it acts.

Two main points on which we do well to reflect to-day emerge from this survey. The first is that while knowledge and reason applied to social conditions by voluntary action have led to a great development of action by the State, this does not end voluntary action or the philanthropic motive; rather it sets them free for new objectives. The State should, in fact, encourage voluntary action of all kinds for social advance, and in every field of its growing activity enlist the services of the voluntary agencies, born of social conscience and philanthropy.

But if this is one of the marks of a free society, Lord Beveridge emphasizes as his second point that the greatest danger of the present situation is not that voluntary action will be abused, but that it may not be able to exist. He asks whether the State will be able to create a machine capable of doing what the numerous affiliated 'friendly societies' did in the most difficult forms of social insurance, of combining soundness with sympathy in the administration of cash benefits to the sick, and whether also it will be able to avoid the evil alternatives of extravagance and harshness. Few who reflect on the extension of State control and responsibility in Great Britain into wide fields of industrial as well as social activity will not admit that there is at present evidence of lack of understanding of the nature of many of the tasks so lightheartedly undertaken.

Nowhere in this report does Lord Beveridge go outside the sphere of social activity; but what he says of the present danger to voluntary or individual action in that sphere can be applied equally well to what is happening in the industrial sphere also. Whatever the merits or demerits of proposals for nationalization of particular industries, they have one consequence that has as yet attracted little attention. The passing of increasingly large areas of industrial activity under State control has repercussions on the freedom of the individual, and the indirect consequences are sufficiently serious to warrant the most careful consideration before, and not after, nationalization has been implemented. A free society ought at least to ask itself whether the surrender of such liberties is too high a price to pay even for proved, as distinct from hypothetical, advantages to the nation in other ways. A recent incident in regard to the dismissal of miners has directed attention to the consequence to the individual of nationalization in a sphere for which there was in principle almost universal approval.

Some considerations of this kind have undoubtedly been in the minds of medical men in their misgivings about participation in the National Health Service on the terms originally proposed to the profession; but the general question has received nothing like the attention it deserves from professional associations, many of which must be at least indirectly affected by many nationalization proposals. There is a further reason why they should give closer attention to this question, brought out more clearly by Lord Beveridge in connexion with his first point regarding the importance of retaining voluntary associations. Such associations—and professional bodies should obviously be included when we no longer limit them to social service in its narrow sense—provide the growing points of society. The essential reason for State encouragement of voluntary action is its value in exploring new ways of social advance, and equally of advance in other fields.

In one of the most significant passages in this report, Lord Beveridge remarks: "In a totalitarian state or in a field already made into a State monopoly, those dissatisfied with the institutions that they find can seek a remedy only by seeking to change the Government of the country. In a free society and in a free field they have a different remedy: discontented individuals with new ideas can make a new institution to meet their needs. The field is open to experiment and success or failure; secession is the midwife of invention. The new institution may fail or may remain limited. It may grow according to the life that is in it, and growing may change the world."

That sentiment Lord Beveridge supports by numerous examples; London owes its 'lungs' to voluntary action, for example. Social survey itself—the impartial study of social conditions and informed criticism of public measures—must always be one of the subjects of voluntary action, for although the State can play a part in this field and is increasingly doing so, the State should never attempt to absorb the whole field. Again, the last stage in totalitarianism would be reached if the use of his leisure were being arranged for each citizen by the State. The main attack on wasteful or harmful use of leisure cannot in a free society be made by direct action of the State. It must depend on the development of alternative interests and free pursuits; it depends on education, in the widest sense of the term, at all stages of life, but above all in adolescence and after.

Here we see a limitless field for voluntary action, assisted where necessary, but not controlled by, the State. In making the first call on the increased leisure of the democracy to fit them for the responsibilities of democracy in choosing leaders and deciding on public issues, we might well demonstrate afresh

what has been one of the most striking contributions of British political sense to world affairs—the ability of public bodies to utilize the services of voluntary institutions. Time after time we have seen philanthropy breaking in on official routine, finding fresh channels for service, getting things done that would not be done for payment.

Voluntary action, however, should not depend on endowments from the past, any more than it should depend on favours from the State. It needs not only money but also service, and here we come back to the danger already noted. There are not so many people to-day with leisure for full-time service as there were in the Victorian age. There are, indeed, many more people with some leisure, and as Lord Beveridge points out, the voluntary services must adapt themselves to use such leisure. Only in that way can we hope to supply, through the efforts of individual citizens, those services needed to make a good society which the State itself cannot supply.

The danger is that the voluntary effort which is the spearhead of advance may not be forthcoming. Opportunity for independent earning and the compelling force of a vital religion are less present than they were, and it is important in one way or another to ensure in future the continuance of the conditions which led to progress in the past. There must be opportunity for independence, and there must be either a revival of the religious motive or an alternative compelling moral or spiritual force to do what religion formerly did in the minds and hearts of men.

These two conditions take precedence over the third, that of a surplus of money available for social experiment. It is the encroachment on these conditions that constitutes the gravest threat to creative work and to the freedom of the human spirit in any sphere of life to-day. In Great Britain, such encroachments are seldom deliberate or direct. The threat to academic freedom, for example, lies less in direct action by the Government than in the consequences of policy in other fields tending to restrict the leisure for thought or research by overloading the teacher or investigator with administrative duties and diverting him from his proper job. The same thought was clearly in the mind of Sir Robert Robinson when he referred in his recent presidential address to the Royal Society to the possibility that current depreciation of fundamental research relative to technological applications might endanger the freedom of science, and insisted on the vital role which the highest kind of disinterested investigation must take in the life of the community.

As regards the social sciences, Lord Beveridge has elsewhere written of the need for a never-ending line of successors to the Webbs. Their output, he pointed out, "was made possible by their being able to put before all other purposes, for most of fifty years, the free conduct of research in fields chosen by themselves. This they were able to do because at the time of their setting up their partnership, they could count on an assured unconditional income of £1,000 a year inherited by Beatrice Potter. By what device will the society of the future be able to ensure that the spiritual successors of the Webbs will have their material resources for research, untrammelled by other duties, by orthodoxy or by prescription of topics? This condition of reasoned progress is not part of the 'new' civilization of Soviet Russia. It must be secured in one way or another in the changing civilization of the Western world."

This third Beveridge report, from the point of view of the man of science, is essentially an exposition of that text. It pleads that the road should always be open for gifted individuals to blaze new trails, and that there should remain the liberty of simple men to associate for action in new forms, for new purposes, free of prohibition either by the State or by associations already established. The philanthropic motive, like the scientific motive, drives men to service by specialized interest. It must be free to experiment and it cannot live under orders. It needs material resources to make its service possible. The dictum of John Stuart Mill, which Lord Beveridge quotes with approval, that "what the improvement of mankind of all their works most imperatively demands is variety, not uniformity", was never truer than to-day and is as valid in the scientific and industrial world as in that of social service.

This book, because it is primarily a challenge to thought, is one that should be read and weighed by all who are concerned for the future of science or of human freedom. There are, indeed, certain general principles indicated which could, and should, be applied far outside the field of social service in its narrower sense. Indeed, some of the suggestions Lord Beveridge makes for action in this sphere have themselves wider applications. He holds, for example, that it is important that there should be command of resources for social purposes in the hands of some living body other than the Government or the State. Thus, in his eight-point programme, he suggests that the Lord President of the Council, who is already minister-guardian of voluntary action in the academic and scientific fields, should be likewise responsible for that surveyed in this report, and he casts something more than a passing glance at the University Grants Committee. He recognizes that the analogy cannot be pressed too far, and that there are serious practical difficulties in entrusting to a similar Voluntary Services Grants Committee the allotment of resources to such an infinitely varied mass of philanthropic agencies. Instead, he suggests rather placing alongside the great charitable foundations, such as the London Parochial, the Carnegie, the Pilgrim and the Nuffield Trusts, an independent corporation endowed by the State for social advance by voluntary action, where departmental interest is unlikely.

Nevertheless, the parallel has implications which should be carefully examined, especially for the long-term issues involved in university expansion. The Nuffield Foundation has provided a sufficient example of the way in which the problem of social advance and social service is related to the needs of the universities and their place in the society of to-day. In their third report the Trustees of that Foundation recorded a belief in the continuing value of private venture as emphatic as that of Lord Beveridge in "Voluntary Action"; and they add that the increase

of State support for learning and research does not lessen the need for voluntary enterprise. Neither does it decrease the importance of alternative sources of support if the principle—fundamental to a free and democratic society—is to be upheld that "there should be room for more than one opinion and for more than one means of putting that opinion to the test". Lord Beveridge's latest report might well be described as an exposition of that text, and a convincing warning of the irreparable damage that can be done to a free society, as well as to learning and culture, should conditions arise, through inertia or neglect, in which voluntary action, enterprise and initiative are starved and atrophied.

GROWTH AND THE GENETICS OF PARTICLES

Growth in Relation to Differentiation and Morphogenesis

(Symposia of the Society for Experimental Biology, No. 2: Published for the Company of Biologists.) Pp. vii+365. (Cambridge: At the University Press, 1948.) 35*s*. net.

THERE would seem to be dozens of different ways of getting at the roots of biology. Each of them promises well at the outset. Experience has shown, however, that the promise is often totally misleading. Of the diverse approaches to the theory of heredity made in the nineteenth century, Mendel's, in fact, seemed the most unpromising. Yet it alone disclosed foundations that could be soundly built upon.

The present symposium on growth (which took place at Oxford and not at Cambridge as the preface states) reveals the same diversity of approach to development that arose at an earlier period in the study of heredity. We find chemical, geometrical, morphological, embryological, cytological and genetical methods expounded by different workers for plants, animals and micro-organisms. A wide field of experiment is covered, and many workers have realized, in spite of Woodger's contrary warning (p. 361), that the most valuable hypotheses are often those which do not appear to be testable to the man who propounds them.

The contrast between workers who are getting to the root of the matter and those who are not is more striking than in any previous discussion of a limited theme in biology. Perhaps all the more so because in their order in this book the papers have been so ruthlessly randomized. One extreme is represented by certain of the botanical papers. "Let us suppose," writes Wardlaw in summing up, "that a greater fund of more precise information stood to our credit." In view of the methods used, this supposition seems to be, *par excellence*, an untestable hypothesis. At the other extreme, the information is available, and it is of the right kind. We can tell that it is of the right kind because workers in entirely different fields find it possible to make use of the same information and the same assumptions. This group is converging on a common point of view, the principle that self-propagating particles variously located are responsible for both growth and differentiation. The problem, as they see it, is to determine the relationships of these particles to one another, in position, in multiplication and in government. The field of operations is the cell and its nucleus. The technique often includes chemistry. The concepts are always in part genetic. It is not surprising that such an enterprise should be most readily developed and applied in unicellular organisms and at the unicellular stage of higher organisms.

Spiegelman's contribution, based on experiments with yeast, is one of the most concentrated and compelling in effect. Spiegelman makes use of the notion of a plasmagene, which he defines (p. 314) as "a more or less complete gene replica which possesses to a varying extent the capacity to self-duplicate". Applying this principle especially from the point of view of the unicellular organism, Spiegelman holds that the permanence or decay of the self-duplicating capacity is not of primary interest. From the point of view of the multicellular organism, however, it is perhaps of primary interest, for does not duration constitute the difference between development and heredity, between differentiation and variation?

Perhaps at the opposite pole to Spiegelman within the genetic field is Hadorn, who looks more directly to the nucleus. As ontogeny progresses, he argues, more genes have to take part in the increasing complexity of the differentiating organism. This would be so, we might suppose, if genes acted for short and specific periods, releasing plasmagenes to accumulate in the cytoplasm during development; and, indeed, Hadorn has shown that the time of action of particular lethal genes (such as are fundamental for development) is different in different tissues. Spiegelman, on the other hand, looks on differentiation as a result of competition between complete populations of plasmagenes, already present in the egg, which thereby become sorted out or unpacked.

A central place in this discussion is taken by Mather, who has brought together a great array of genetic and cytological facts to show their hitherto unrealized importance for the theory of differentiation. Mather's theory, for which he provides a detailed model, is the only one which makes effective use of the evidence of plant embryology. Indeed, this hitherto barren study of the embryo-sac and the pollen grain can obviously provide one of the most fruitful fields in the estate. Other flashes of light are in Holtfreter's attempt to relate the results of experimental embryology to the new genetic notions, and to introduce parthenogenesis and carcinogenesis into the discussion, and in Wigglesworth's comparison (suggested by Gregory's studies) between the diapause of insects and the resting stage of the plant seed.

If we look back over the developments which are now leading to synthesis, we can trace them to unexpected sources not of classical embryology so much as to Mendel, Miescher and Weismann through a long line which includes Boveri and Morgan, and recently Brachet and Caspersson. An important debt is also owed to those who have laboriously sorted out the actions of the nucleus and the cytoplasm in the cell, especially to Baur and Renner. This is the only work in which plants made the crucial contribution, one the importance of which was so generally overlooked until Sonneborn had made his beautiful analysis of the Kappa action in *Paramecium*. We may say in brief that these great advances, these great entrances, have rarely been made by those who knocked at the front door and stood and waited for an answer, but largely by those who have been sharp enough to see a side window left carelessly ajar and to climb in by it.

It might seem in this way that the method of discovery was accidental, informal—even illegitimate.

This, however, is not so. It has been the painful pursuit of ultimate determinants which has proved successful. It was inevitable that this method should first arise in heredity—and even in the long-term heredity of the higher organisms. From one point of view, to be sure, heredity is merely the repetition of development. From another, however, heredity presents the same consequences of protein propagation as development does, but on a larger field—as though seen through a diminishing glass. It enables us to separate what is permanent from what is temporary; and although one of the authors does not wish us to exaggerate the importance of this distinction, it is in practice a mighty convenient one. The foundation of all physiology must be the physiology of permanence.

The present symposium in these ways puts the recent history of fundamental biology in a new light; and at the same time it reveals the new notions and methods that are likely to be important in the study of growth and differentiation in the coming years.

C. D. DARLINGTON

SOCIAL ASPECTS OF MEDICINE

Changing Disciplines

Lectures on the History, Method and Motives of Social Pathology. By Prof. John A. Ryle. (Oxford Medical Publications.) Pp. xv + 124. (London: Oxford University Press, 1948.) 12*s*. 6*d*. net.

IT is always a pleasure to read a book which combines the logic of scientific thought with the warmth of human understanding. In a series of essays, the author defines his subject as "the medicine and the pathology of families, groups, societies or larger populations". This includes the study of health in its many variations—because a knowledge of the normal is necessary for recognizing the abnormal—and the social causes and remedies of disease. As professor of social medicine in the University of Oxford and director of the Oxford Institute of Social Medicine—the first of its kind in Great Britain—Prof. J. A. Ryle is engaged in pioneering work in a field which, in a more restricted sense, used to be known under the name of 'public health'.

A hundred years ago, when William Farr turned vital statistics into a weapon against disease, social medicine received its first scientific equipment; but the unfortunate separation between preventive and curative medicine which ensued gave it little chance to grow up to its full stature. The cure of the sick individual, largely in isolation from his environment, remained in the foreground of medical thought, while public health concerned itself with sanitation and epidemic disease without paying much attention to the individual in his social setting. Social medicine now "places the emphasis on *man*, and endeavours to study him in and in relation to his environment".

The author describes the work done by the Oxford Institute since its inception in 1942, and by the Oxford Bureau of Health and Sickness Records which works in close association with it. He is convinced that "the whole natural history of disease in human communities, as well as in individuals, is ripe for fuller and more exhaustive study". To-day, as in the past, the relation between poverty and disease forces itself upon the practitioner of social medicine at every step, demonstrating the failures, and occasionally also the successes, of society. Out of the figures of the occupational, geographical, sex, and income distribution of death and disease, new knowledge and a new discipline are emerging. Statistical correlations between tuberculosis and social class, between the incidence of skin cancer and occupation, and between stillbirths and the nutrition of mothers, reveal as many facts as the laboratory and the X-ray plant. Much of the present knowledge is still awaiting application. In his study on "Social Medicine and the Population Problem", the author counts the lives that could be saved every year if the present lessons of social medicine were applied. But an infinitely greater amount of detailed information about the social background of disease could be made available with greater effort and a new approach in medicine. With the institution of the National Health Service there is, at last, the opportunity of developing a national system of records which would supply as much information about sickness, its distribution and its character, as we have had on mortality for many decades. To-day, in the absence of such records, it is not possible to assess effectively the results of particular methods of treatment.

In his lecture on "Medical Ethics and the New Humanism", Prof. Ryle draws a number of conclusions for the future role of the medical profession. He urges his colleagues to play a more constructive part than they have played in the past by adapting the methods of medicine to human needs in a changing society. "Human justice—by the standards of vital statistics—is still a shoddy affair", and this fact has a close bearing upon medical ethics. "Possessing the knowledge which we now possess, is it not the duty of physicians everywhere, as Prof. Sigerist has urged, 'to assume leadership in the struggle for the improvement of conditions' ?" This demands not only a change of emphasis in the training of medical students, but also a wider conception of medical ethics, "a new and broader and more intellectually inspired sense of duty to our communities and to the race and to the individuals".

This book, written in the restrained language of the man of science, contains a challenge. It should be read not only by medical men and people closely associated with medicine, but also by all those who are concerned with the social problems of our time.

H. FITZGERALD

PROPAGATION OF TREES AND SHRUBS

Propagation of Trees, Shrubs and Conifers

By Wilfred G. Sheat. Pp. xii+479. (London: Macmillan and Co., Ltd., 1948.) 25*s*.

THE author has had wide experience in propagation in nurseries in New Zealand and in Britain, and writes as a practical man for practical men. He has brought together in this book the results of his own experience and that of others engaged in commercial propagation of trees and shrubs, and set forth, in handy form, the methods he has found most successful in practice in dealing with individual species and varieties.

The book is divided into two parts; the first and longer dealing with the angiosperms, and the second with the gymnosperms. In each of these parts there is first an account of the different methods of propagation (by seed, division, layering, cuttings, grafting,

budding) applicable to different members of the group, and this is followed by a detailed description of the methods recommended, for each of the genera arranged in alphabetical order, with special subsections for any species or varieties which require different treatment. This arrangement is an excellent one for the purpose of the book. Anyone faced with the problem of propagating a particular shrub or tree will find at once, under the genus heading, a description of the various methods which are practicable, with the necessary details as to time, cutting or grafting material, treatment, etc., with recommendations as to which method to adopt under various conditions. Reference to the introductory section will only be necessary for the novice or amateur who is not familiar with the general technique, and the expert in general horticulture receives just the details he requires to supplement his knowledge, when faced with the propagation of a plant he has not hitherto tackled. On the other hand, even the expert will find valuable suggestions in cases with which he is already familiar in practice.

This arrangement of the work undoubtedly involves a great deal of repetition. Many of the methods are applicable to a number of the genera; but the great advantage is that those who consult the book do not have to refer to different places for such information as they require, but can, as a rule, obtain it in one or two pages.

In the general description of propagation methods at the beginning of the first part, the appliances for raising plants under glass, cold frame, sun frame and close frame are discussed and drawings given of practical and useful types. Moreover, excellent diagrams and illustrations are provided of the different ways of preparing and planting cuttings, and carrying out the various methods of grafting and layering.

The author has not included in his prescriptions the use of hormones or chemical substances to induce root production. He quotes one experiment in which, though treated cuttings rooted more quickly and more abundantly than untreated ones, the subsequent behaviour of the plants indicated that the untreated ones soon overtook the others in growth and showed more vigour. He suggests that further experiments should take into consideration the ultimate condition of the plant, that is, for a period of three years at least, or until it is quite certain that no detrimental effect on the plant has been sustained in the process of propagation. He thinks that, up to date, no real commercial advantage has been gained by the use of growth substances for the propagation of plants by cuttings. In his view, it would be advisable if research stations based their experiments on the question of desirability of method rather than possibility. From the practical point of view there are often other methods of propagation more suitable than the use of cuttings. This is doubtless often true in the case of ornamental varieties of trees and shrubs where small quantities may be propagated by grafting or layering; but the help of growth substances may prove very valuable where, for example, difficult species, such as the Abietineæ, have to be reproduced vegetatively for the purpose of building up stocks of special genotypes for breeding purposes or ultimate production of supplies of *élite* seed. This book, however, is concerned with ordinary practice, and special strains of the Abietineæ of ornamental value are few. Glaucus varieties of cedar, *Picea pungens*, etc., may be raised in small numbers by grafting or cuttings by the methods described in the book; but even in these cases the author recommends the selection of the most desirable individuals from batches raised from seed. The Cupressineæ and most of the other conifers do not present special difficulties.

The completeness of the descriptions of different methods of propagation, helped by Mr. O. Miller's excellent illustrations, the sound advice given and the convenient way in which the subject-matter is arranged, combine to make the work a first-rate handbook of its subject, which will be of the greatest value to all who are interested in the propagation of trees and shrubs. It will probably form a standard text-book of this branch of horticulture.

T. Thomson

THE PRACTICE OF FARMING

Profitable Ley Farming

By John Laity. (Agricultural and Horticultural Series.) Second edition, revised. Pp. xiv + 271 + 26 plates. (London: Crosby Lockwood and Son, Ltd., 1948.) 15*s*. net.

How many of us, after a walk with a competent farmer round his crops and stock, have later endeavoured to recapture the essentials of his system and his particular approach to the tricky problems that farming, of all occupations, provides? These efforts to record other people's experience are only partially successful because, in the course of ordinary conversation, it is not possible to enter another man's mind or obtain a sufficiently exact picture of his operations. The only real way is for the farmer to make the record himself, and for various good reasons practically no farmer will do it. Journalists turned farmer may do so, technically minded individuals with a 'system' will do so, but not, as a rule, plain farmers. Mr. John Laity is an exception. His book is a straightforward account of the style of farming that he has developed and found successful in the course of many years on his farm near Mount's Bay in Cornwall. The basis is good grass to support a sound livestock husbandry and to provide, when ploughed up, a reserve of fertility for arable cropping. Great importance is attached to the seeds mixture, which closely follows the Clifton Park prescription of drought-resisting species and excludes rye grass. Although Mr. Laity has obviously studied the technical side of farming—"one of my hobbies in life," he says, "has been the reading of old and new writings on agriculture"—he obviously has an independent and critical mind, and some practices, which in his hands are claimed to give good results, may appear to conflict with accepted doctrine.

The whole scheme of farming is taken crop by crop and described in considerable detail, yet in an almost conversational style. The chapter on broccoli is a case in point; the reader feels that he could almost set about growing broccoli after studying these twenty-two pages. There is room for more books like this. The recording of successful practice is an important branch of agricultural literature. Undoubtedly much of the success is to be attributed to energy and ability in management, as distinct from the ready adoptions of technical advances; but the operations of these men always throw up questions that may well be the subject of critical examination, not by the farmer himself, for no farmer has the time or resources for this, but more appropriately by the experimental station or husbandry farm.

OBSERVATIONS WITH ELECTRON-SENSITIVE PLATES EXPOSED TO COSMIC RADIATION

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WE have recently made observations with the new Kodak nuclear research emulsions, described by Dr. R. W. Berriman[1], which record the tracks of particles of charge e, even at minimum ionization. The new plates represent a technical advance of great importance; they allow us to obtain a much deeper insight into nuclear processes than was possible with the older emulsions, and they greatly extend the field of application of the photographic method to physical and biological problems.

In Part 1 of the present paper, some of the more important processes involving charged mesons, which can be observed when the new plates are exposed to the cosmic radiation, are described. They include examples of disintegrations produced by π^--particles; and the decay of μ-particles. In about 10 per cent of the cases, the track of the particle produced by the decay of a μ-meson has a length in the emulsion greater than 1,000 μ. By studying the Coulomb scattering of these particles in their passage through the emulsion, estimates of their energy can be obtained.

A striking feature of the exposed plates is the large number of tracks with a grain-density corresponding to that of particles near minimum ionization. These tracks provide a very simple test for 'fading', for the variation of the degree of development with depth, and for the sensitivity and other characteristics of the emulsions.

In Part 2, an event is described which provides further evidence for the existence of mesons of greater mass than the π-particles[2]. A particle, of which the mass, as determined by grain-counts, is about 1,000 m_e, comes to rest and leads to the emission of three charged particles, one of which reaches the end of its range in the emulsion and produces a disintegration. Evidence is given which suggests that the event corresponds to the spontaneous disintegration of the heavy particle. Assuming that the three charged particles observed are the only products of decay, the event can be analysed by applying the principles of the conservation of mass-energy and of momentum. It is then found that the observations are consistent, to within the errors of the measurements, with the assumption that the three secondary particles are π- or μ-particles.

Before the correctness of this interpretation can be taken as established, it will be necessary to observe further examples of the same process. We give this preliminary account of the observations, however, because the number of particles of this type, compared with that of π- and μ-particles, appears to be small at moderate altitudes (11,000 ft.). Further, if our assumptions are correct, only a small proportion of such events will, for purely geometrical reasons, permit a detailed analysis of the type we have been able to make. Taken in conjunction with the present observations, however, other events of a similar character, although less suitable for analysis, would provide important information supporting or disproving the correctness of our suggestions.

PART 1. DECAY OF μ-MESONS

Experimental

The plates employed in the present experiments were experimental Kodak emulsions, type *N.T.4*, kindly supplied by Dr. R. W. Berriman. They were transported to the Jungfraujoch immediately after manufacture and some were placed beneath a block of lead 10 cm. thick for periods of from eight to sixteen days, others being left uncovered. The lead block was employed in order to reduce the intensity of the soft component; but it appears to have been an unnecessary precaution, for the number of tracks in the unshielded plates is not inconveniently large. The plates were developed at the Jungfraujoch immediately after exposure. Different plates were processed in different baths in an attempt to determine the most favourable conditions of development, and there are corresponding differences in the grain-density of the tracks of similar particles in different plates.

Because of the short exposure, the number of events per unit area is relatively small, but the greatly increased grain-density in the tracks, due to the higher sensitivity of the emulsion, makes it possible to search plates under the microscope with a much lower magnification than that previously employed. Thus, in searching for mesons, we have employed a $\times$ 10 objective and $\times$ 6 eyepieces. With a binocular microscope, this equipment gives an overall magnification of only $\times$ 90. It is thus possible to increase the speed of search of the plates, and in an examination of 300 cm.^{2} of the new plates, many examples of familiar processes involving charged mesons have been found.

Disintegrations Produced by π^--Particles

The observations include thirty examples of disintegrations produced by π^--particles (see Fig. 1), and thirty examples of π^+-particles which suffer μ-decay. A notable feature of the new plates is the large number of tracks of slow electrons which can be clearly seen under the microscope. In Fig. 1, for example, two electrons appear to be associated with the star produced by the nuclear capture of a π^--particle.

The tracks of electrons originate only rarely from the point at the end of the range of π^--particles where the disintegration occurs (see Fig. 2). Thus of thirty disintegrations produced by π^--particles, only three show the tracks of associated electrons. This result appears to have a bearing on the processes by which a π^--particle loses energy in falling to a k-orbit around a nucleus. In those cases in which electrons are observed, they may be attributed to the β-decay of the residual nucleus formed by the disintegration;

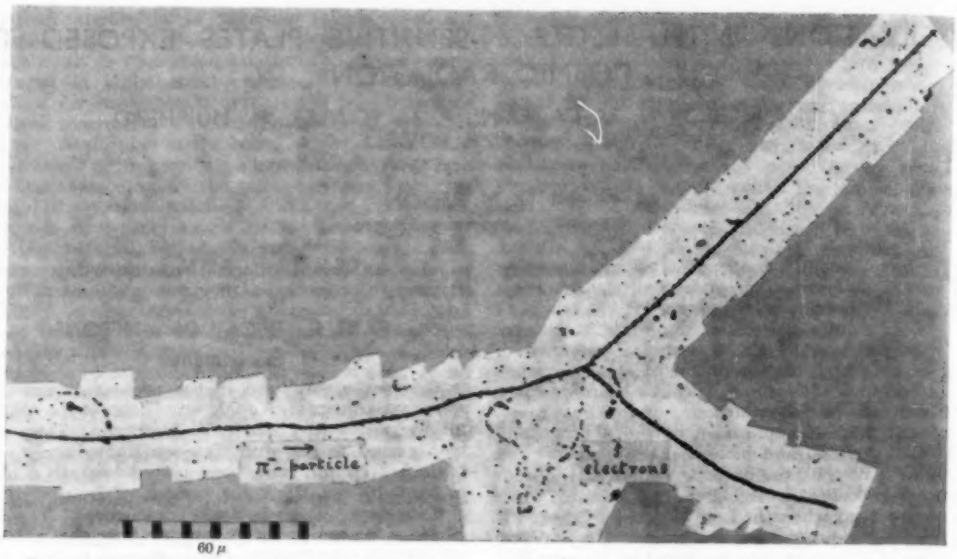


Fig. 1. Disintegration produced by π^--particle showing tracks of associated electrons. Observer: Mrs. W. J. van der Merwe

or possibly to the internal conversion of γ-rays. If the meson sometimes loses energy by the ejection of Auger electrons, the number of such electrons, of energy greater than 15 keV., must be small.

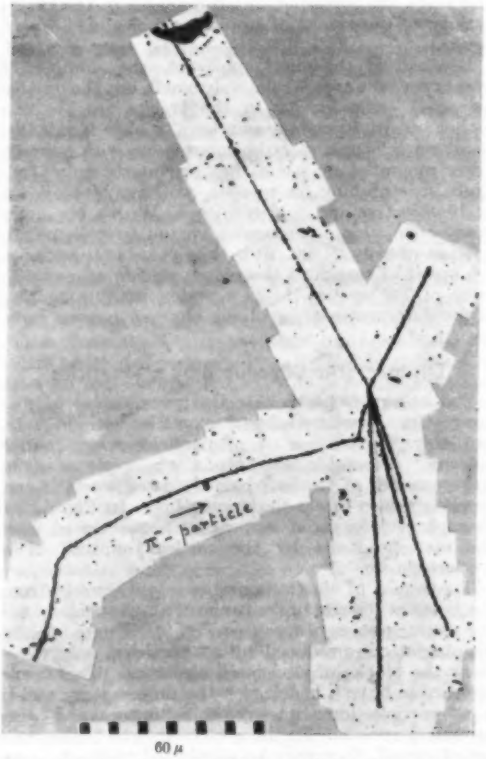


Fig. 2. Disintegration produced by π^--particle. Observer: Mrs. W. J. van der Merwe

Particles of Low Specific Ionization

In addition to the phenomena with which we are familiar, we can distinguish in the new plates the tracks of many particles of low specific ionization which pass across the emulsion, from the surface to the glass, without suffering a deviation, through scattering, of more than a few degrees. These may be attributed to fast particles, mostly electrons and mesons, with a specific ionization near the minimum value for a particle of charge e. In order to confirm this view, grain-counts were made on twenty-five tracks of this type, of length greater than 1,000 μ, chosen at random from a particular plate, No. K 47. The results of this study are represented in Fig. 3, where the relative frequency of occurrence of tracks with different values of the average grain-density is shown. The plate was one of those exposed under the lead block.

It will be seen from Fig. 3 that there is a sharply defined group, with a mean grain-density of 0·22 grains per micron. We regard this group as due to particles with a specific ionization near the minimum value. The observations can be explained in terms of the slow variation with energy of the ionization of particles of momentum greater than 2 mc, where m is the rest-mass.

The results represented in Fig. 3 prove that effects due to fading of the latent image are small, for fading will tend to reduce the grain-density. Had such effects been appreciable, a dispersed set of values for the grain-density of particles with minimum ionization would have been expected—corresponding to the

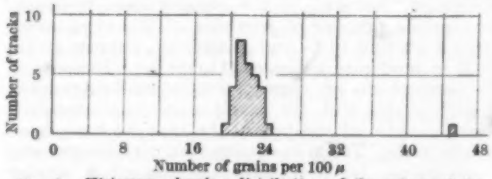


Fig. 3. Histogram showing distribution of the values of the average grain-density in tracks of low specific ionization

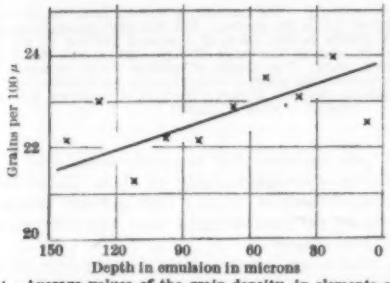


Fig. 4. Average values of the grain-density, in elements of the tracks of 25 particles of low specific ionization, at different depths in the emulsion

presence of tracks of different 'ages'—instead of the sharply defined group actually found.

The tracks under consideration pass right through the emulsion. They can therefore be studied in order to determine the variation of the degree of development with depth. The grain-density along the tracks has been measured as a function of the depth in the emulsion, and the mean results for twenty-five tracks are represented in Fig. 4. It will be seen that the grain-density corresponding to minimum ionization varies with depth, in the particular plate under examination, from 23·5 per 100 μ at the surface, to 21·5 at the glass.

It follows from this result that the changes in the grain-density in a track, due to a variation of the degree of development with depth, are less than 8 per cent. Further, a correction can be made, to allow for the small variations observed, in the case of tracks of low specific ionization which are of particular interest. Long tracks of small grain-density are a common feature in electron-sensitive plates exposed to the cosmic radiation, and the above methods may therefore be useful as a standard procedure for determining, (*a*), the degree of fading in a given exposure; (*b*), the degree of development with depth; and (*c*), the grain-density corresponding to the minimum value of the specific ionization of a particle of charge *e*.

A second conclusion follows from the results represented in Fig. 3. The magnitude of the minimum value of the specific ionization of a particle is proportional to the square of its charge. The sharply defined peak, shown in Fig. 3, proves that the great majority of the fast particles recorded by the emulsion have charges which are equal, to within about 5 per cent. This makes it almost certain that the charge in question is of magnitude *e*.

Decay of μ-Mesons

The tracks of 100 μ^+- or μ^--particles, which reach the end of their range in the emulsion and emit a single charged particle of low specific ionization, have now been observed. A mosaic of photomicrographs of such a disintegration is reproduced in Fig. 5. Events of this type can be easily distinguished from those in which a π-meson decays to produce a μ-meson, because of the much greater grain-density in the track of the latter particle, when it is formed by the decay of a π-meson at rest. Further, the particles appearing at the end of the range of the μ-mesons, if ejected in a direction nearly parallel to the surface, commonly have a range of several thousand microns before leaving the emulsion. Such particles are very little scattered, and they have a grain-density nearly equal to that corresponding to minimum ionization. This observation shows the particles to have the electronic charge.

Fig. 6 shows a mosaic of photographs of an event in which a π-particle stops in the emulsion and emits a μ-particle of range approximately 600 μ. The particle of low specific ionization which originates from the end of the track of the μ-particle can be clearly seen. In eight other events of this type which we have observed, the secondary particles all have characteristics indistinguishable from those of the particles arising at the end of the range of the μ-mesons which enter the emulsion after originating at points outside it. Taken in conjunction with evidence obtained in previous experiments, the new observations provide additional weight for the assumption that the μ-mesons are identical with some at least of the ordinary mesons of the penetrating component of the cosmic radiation; and that the π- and μ-mesons carry electric charges of magnitude *e*.

About 10 per cent of the μ-mesons, which stop in the emulsion after being created at points outside it, give rise to a particle of which the track in the emulsion has a length greater than 1,000 μ. We have considered the possibility of determining the values of the momentum of these particles by making observations on the change in their directions of motion in the emulsion, produced by a magnetic field of 50,000 gauss. A simple calculation shows, however, that the deflexions would be of the same order of magnitude as those to be expected from scattering. Observations were therefore made on the scattering of the particles in the absence of a magnetic field, the method employed being similar to that described previously[4]. The following values are typical of those obtained by this method, and show the order of accuracy which can be obtained in favourable cases: 15 ± 3, 25 ± 5, 38 ± 6, 42 ± 2, 44 ± 4, 48 ± 6 MeV./c. The limits correspond to the probable errors associated with the statistical fluctuations.

It is reasonable to suppose that, in the course of a few months, we shall find some hundreds of tracks of

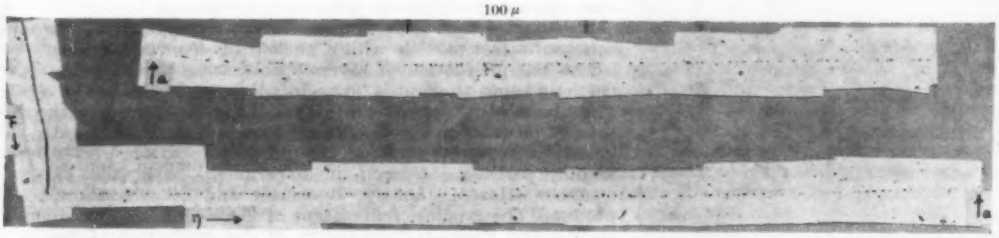


Fig. 5. Characteristic example of the track of a particle of low specific ionization, produced by the decay of a μ-meson. The track of the secondary particle is given in two parts which should join at the points marked *a*. Observer: Mrs. B. A. Moore

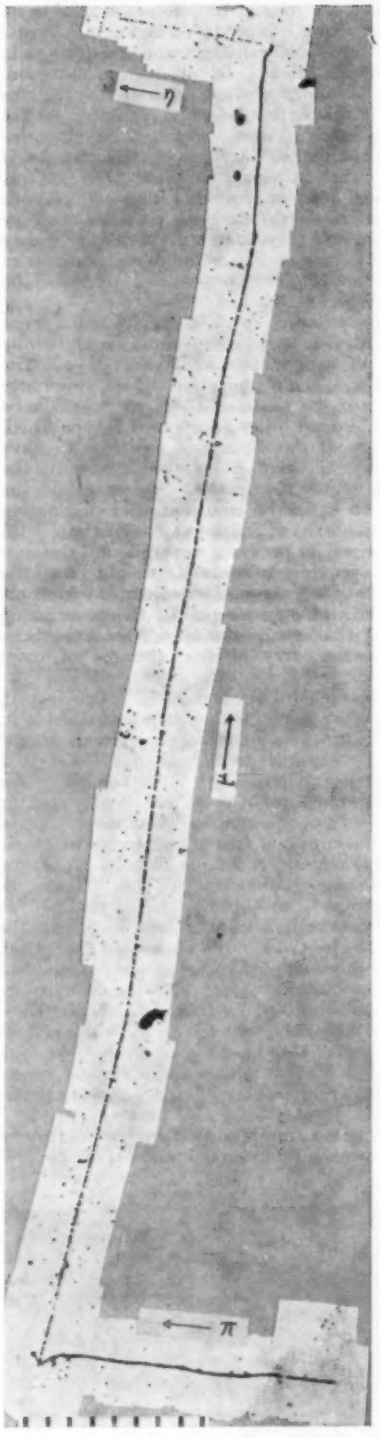


Fig. 6. Successive decay $\pi \rightarrow \mu \rightarrow \eta$. The particle, η, arising from the decay of the μ-meson, is commonly assumed to be an electron, but this assumption remains to be finally established. A few grains in the track of a second particle of low specific ionization can be seen near the end of the range of the μ-meson, but this particle is not associated with the main event. The tracks of several δ-rays produced by the μ-meson, one of which occurred near the point at which the π+-particle decayed, can be distinguished. In every example observed hitherto, the particle η leaves the emulsion. Observer: Miss R. Brown

such particles which are suitable for measurement, and that it will be possible to make a detailed study of their distribution in momentum; the values obtained on the first twenty tracks with a range greater than 1,000 microns suggest that the momentum of the decay particle is not constant.

Of the μ-particles which are observed to stop in the emulsion, about 40 per cent give rise to no secondary particles of which the tracks can be distinguished. These may be assumed to be either μ^--particles which have been captured by silver or bromine atoms, and which therefore interact with nuclei before they have had time to decay; or, to be events in which the decay particle escapes observation because of its direction of ejection. In order to estimate the number of events which can be attributed to the latter process, the lengths of the projections of the tracks of the decay particles, on the surface of the emulsion, have been measured. From the distribution of the values thus obtained, the total number of μ-mesons producing secondaries can be estimated. The problem is purely geometrical, and the approach is identical with that employed previously in the case of the μ-decay of π-mesons[4]. We have thus found that of the μ-mesons observed, 65 ± 10 per cent emitted secondaries, and 35 ± 10 per cent gave none. This result appears to be consistent with previous estimates of the proportions of the μ^--particles which stop in gelatine, and in silver bromide.

We have suggested that the observations on the disintegrations produced by π^--particles indicate that Auger electrons of energy greater than 15 keV. are only rarely produced during the 'atomic capture' of a negative meson. A similar conclusion follows from a study of the tracks of the μ-particles. Of the hundred events in which we can distinguish the track of the fast particle arising from the decay of a μ-meson, there is no case in which the track of an electron of short range, arising from the point of disintegration, can be distinguished. It is reasonable to suppose that in about a third of these events we are observing the spontaneous decay of a negative meson. It follows that for the μ^--particles also, the ejection of Auger electrons, of energy greater than 15 keV., during the process of atomic capture, is a rare phenomenon. A closer study of this problem would appear to be desirable; for in the case of μ^--particles which decay spontaneously, no confusion due to the β-decay of a residual nucleus, following meson capture, can occur.

Showers of Penetrating Particles

In examining the 'stars' produced in the new emulsions, we have observed eight cases in which five or more charged particles emerge which produce tracks having a grain-density near the value corresponding to minimum ionization. In each case, these particles moved downwards in directions making only small angles with the vertical, so that they are confined to a narrow cone. They are accompanied by protons and α-particles of low energy which were ejected in directions orientated at random.

We suggest that each of these events corresponds to the interaction of a fast particle with a nucleus of silver or bromine, which led to the production of several penetrating particles, the heavy particles being afterwards 'evaporated' from the nucleus as a result of its increased 'temperature'; that the events represent the same type of process for which evidence has been given in recently published photographs showing the production of showers of penetrating particles obtained in experiments with the expansion chamber (Hazen, Jánossy, Rochester and other authors). The processes observed are reminiscent of those visualized by Hamilton, Heitler and Peng, in their theory of the production of mesons by the interaction of fast nucleons with nuclei.

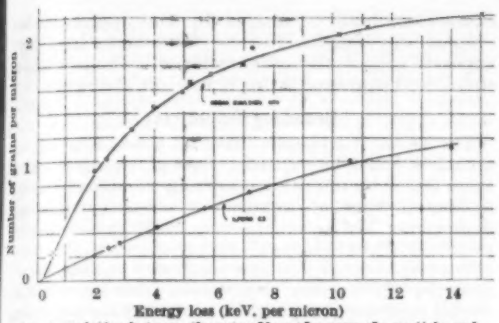


Fig. 7. Relation between the rate of loss of energy of a particle and the grain-density in the track. Points marked —o—o have been deduced from observations on the tracks of μ-particles of range greater than 2,000 μ; and those marked —×—×, from similar measurements with protons

Relation Between Grain-Density and Specific Ionization

It is a matter of great technical importance to be able to infer the specific ionization of a charged particle from the observed grain-density in its track in an emulsion. We have seen that curves of the type represented in Fig. 3 allow us to determine the grain-density in the tracks of particles of charge e, corresponding to minimum ionization. Further, from observations on the tracks of μ-mesons and protons of great range, observed in the same plate, we can determine the grain-density corresponding to a wide range of values of the specific ionization. In making such determinations, the rate of loss of energy corresponding to a given value of the residual range of a particle of known mass can be determined from the range-energy curve for protons. In this way, we have obtained the results represented in Fig. 7. The point corresponding to minimum ionization in this figure is shown thus +, the ionization having been determined in this case from the formulæ developed by Bloch, assuming the atomic composition of the emulsion to be identical with that of the Ilford plates.

Included in Fig. 7 is a similar curve for an Ilford *C* 2 emulsion. It will be seen that, as a result of the increased sensitivity of the Kodak *N.T.*4 emulsion, there is a reduction in discriminating power for tracks with a specific ionization of the order of 6 keV. per micron. In the Kodak plates, a track, in regions of high ionization, appears as an almost continuous succession of developed grains which cannot be individually resolved. This has the result that for determining the mass of particles of mass approximately 1,000 m_e, tracks of much greater length must be available for measurement than is the case with less sensitive emulsions.

In contrast with the difficulties met in the case of tracks with a high specific ionization, the calibration curve shown in Fig. 7 allows us to make estimates of the rate of loss of energy for weakly ionizing particles, a technical advance of great importance in relation to the subjects discussed in Part 2 of the present paper.

(To be continued)

[1] Berriman, *Nature*, **162**, 992 (1948).
[2] Leprince-Ringuet, *C.R. Acad. Sci., Paris*, **226**, 1897 (1948). Rochester and Butler, *Nature*, **160**, 855 (1947). Bradt and Peters, Report to the Bristol Symposium, 1948 (in the press). Alichanian, Alichanov and Weissenberg, *J. of Exp. and Theoret. Phys., U.S.S.R.*, **18**, 301 (1948); and other references.
[3] Camerini, Muirhead, Powell and Ritson, *Nature*, **162**, 433 (1948).
[4] Goldschmidt-Clermont, King, Muirhead and Ritson, *Proc. Phys. Soc.*, **61**, 138 (1948).
[5] Lattes, Occhialini and Powell, *Proc. Phys. Soc.*, **61**, 173 (1948).

PROBLEMS AND POLICY IN PLANT BREEDING

THE second annual Conference of Plant Breeders under the auspices of the Agricultural Research Council was held during November 11–12 at the John Innes Horticultural Institution. Sixty-four members attended, including representatives of English, Scottish and Welsh plant-breeding stations, some overseas visitors, and geneticists from the universities. Prof. F. T. Brooks represented the Agricultural Research Council. Dr. C. D. Darlington was in the chair.

Demonstrations

(1) The Genetics Department of the John Innes Horticultural Institution demonstrated genetical problems in seed-growing, rogues in tomatoes, the spontaneous and induced mutation of the incompatibility gene, *Phaseolus* hybrids and the effects of selection in *Drosophila*.

(2) The Pomology Department showed new mildew-resistant tomatoes, incompatibility in pears, the breeding of sweet corn and 'bolters' in potatoes.

(3) The Cytology Department showed iso-chromosomes and heterochromatin in plants. Chromosome numbers were used to reveal the origin and development of the cultivated daffodil since 1890. In earthworms meiosis was shown in a tetraploid species —a novelty in animals—and the relations of chromosome numbers to species were illustrated in this group.

(4) The Garden Department demonstrated soil sterilization and artificial illumination as aids to the breeder.

PROBLEMS

Quantitative Inheritance and Selection

Prof. K. Mather, in the opening talk, gave an outline of the methods available in the study of quantitative inheritance. The Mendelian method of experiment, he pointed out, can be applied only to differences caused by genes of large effect. Biometrical methods can be used with all differences, including quantitative variation which is controlled by polygenes. Mendel's principles apply to nearly all heritable variation in higher organisms, and therefore have been used as the basis for biometrical analysis.

On this basis methods had been developed of measuring polygenic variation; of partitioning such variation into non-heritable, heritable and fixable, and heritable but depending on dominance and therefore unfixable; of testing for residual genic interaction and for linkage; and of finding the number of effective units of segregation. By these means the magnitude and speed of progress under selection could be predicted in some circumstances, and the progress of inbreeding could be measured experimentally.

Most of the variability was normally hidden, and its exposure to the action of selection depended on crossing, segregation and recombination. These processes were controlled in Nature by the natural breeding system and by the frequency of chiasma formation.

Control of the breeding system is a regular tool of plant breeding; and the control of recombination by adjustment of the environment may become another.

Correlated responses in characters other than those under direct selection, Prof. Mather suggested, might also be useful as a means of splitting up stabilized

polygenic complexes and as markers for selection in the juvenile stage. A possible example of correlated responses in adult plant characters to selection of seedlings with abnormal cotyledons was described by M. G. M. L. Haskell.

From hybrids and varieties of sweet corn brought back from the United States, Mr. Haskell said that he had selected seventy-seven and compared them with Canada Gold and Extra Early Bantam, the best varieties so far known in Britain.

The geographical origin was of considerable importance. Hybrids from Connecticut, in some instances, were early and promising, those from Wisconsin too late. Those from Ottawa varied in potentiality; but all had the sweetest flavour.

From observations of inbred lines obtained from Connecticut, Wisconsin and Indiana, it is clear that good ones for Great Britain can only be obtained by producing them here. Inbreeding had begun on selected cold hardy lines of Canada Gold and other material in order to obtain cold-hardy inbreds which would produce good hybrids.

Dr. S. C. Harland, in a talk on the inheritance of seed weight in *Ricinus communis*, showed that in the F_1 and F_2 the mean seed weight is close to the geometric mean of the parents. Successive back-crosses to the small parent approached the latter by a series of geometric means. It was not clear whether this would continue until the frequency distributions are indistinguishable from that of the recurrent parent or whether bimodal curves began to occur, indicating monogenic segregation. Results were not inconsistent with about eight factors for seed weight, one of which was linked with waxy bloom.

Rogues and Cytoplasmic Inheritance

The next two speakers dealt with the problem of aberrant plants which continually occur in tomatoes and potatoes. Dr. D. Lewis described the rogue tomato as an old mystery to the geneticist and a source of loss to the grower. Normal plants produce rogues in a percentage varying according to the variety; rogue plants produce rogue and normal offspring. As tomatoes are pure lines, only an elaborate and improbable genic control can be postulated. Working on Darlington's hypothesis that the rogue was mainly controlled by a plasmagene, it was found that, as with other plasmagenes, their activity was subject to environmental conditions. For example, temperature at germination had a profound effect; with the variety Ailsa Craig at 13° C. there are only 1·7 per cent rogues, at 26° there are 12·9. Intermediate types of rogue plants are produced when short periods of high temperature are given during germination. The number of rogues produced also varied with the inflorescence from which the seed was obtained. The proportion was low from the first and second, high from the third and fourth, and low again in the fifth.

Although the breeder did not often have to work with characters controlled by plasmagenes, Dr. Lewis suggested that bolting in beet, brassicas and onions were examples. It was clear that the breeder must take care when selecting for such characters to do it in relation to a controlled environment.

Mr. S. H. Revell described the widespread and sporadic occurrence of 'bolters' in potatoes. The breeding behaviour indicated that there was not a simple genic control of the bolter characters. Frequent somatic mutation could explain most of the facts. The expression of the normal and bolter characters could be altered by the application of different day-lengths. Normal plants under long days appeared to be bolter in character, while bolters under short days appeared more normal in character.

Breeding Apomicts

Dr. D. G. Catcheside showed how variation in apomicts could be expected through changes which arose either by mutation occurring somatically or by a limited kind of segregation occurring through diplospory. The variations were likely to be rare and relatively slight in amount on any occasion. It sometimes happened, as in the composite rubber plant, guayule, *Parthenium argentatum*, that facultative sexual reproduction provides a method for obtaining numerous definitely known recombinants for testing.

In apomictic 72-chromosome guayule, a reduced egg in the embryo sac could form a 36-chromosome embryo. The resulting 'haploid' plants were usually apomictic. As in other guayule apomicts, the unreduced eggs were sometimes fertilized to give an apomict with a higher chromosome number. In the production of pollen in a 72-chromosome apomict there was nearly always reduction in the chromosome number and generally genetic segregation. If a 'haploid' with 36 were pollinated by a 72-chromosome plant, the resulting progeny would contain a small proportion of 72-chromosome plants, each the result of a distinct fertilization, and each could form the foundation of a new selection test-line. Segregation in the pollen parent would be demonstrated by greater variation among these progeny than among the apomict progeny of the male parent. This was the basis of a method of readily finding small variations in apomict stock, and it could be developed by searching for élite 'haploids' giving superior offspring in crosses, analogous to the élite inbreds in corn.

Experimental Design

Dr. F. Yates, speaking on the best methods of selecting and testing varieties, said that the design of field trials had progressed to a stage where satisfactory designs could be recommended for a wide range of requirements. But there was a serious lack of information on the optimum degree and accuracy of selection at each stage in a breeding programme. In the use of 'control' varieties as standards from year to year it was important to use more than one, as this overcomes differences of any one variety in response to different conditions and allows for changing the controls in the middle of a long-term experiment if any variety becomes obsolete.

It was generally agreed that the subject was of such importance that a whole session of next year's conference should be allotted to it, in the hope that, by that time, more information would be available.

POLICY

Seed Growing

Dr. A. J. Bateman pointed out that the maintenance of varieties produced by the breeder was of vital importance to him. Seed-growing presented many problems which required scientific study. With inbred crops: the degree of heterozygosity after single plant selection, the importance of mutation, and the degree of uniformity desirable. With cross-bred crops: the effects of natural selection, the prevention of undesirable cross-pollination and the size of populations necessary to maintain a variety properly. There was therefore a need for knowledge on the genetical aspects of stock seed maintenance

and for a greater control by plant-breeding stations over the maintenance and multiplication of their products. In the discussion, Dr. G. D. H. Bell pointed out that, at Cambridge, the National Institute of Agricultural Botany collaborated to maintain seed stocks. Dr. O. H. Frankel urged that co-operation with private seed firms would greatly improve the position, and Dr. J. Philp thought that breeders could obtain this co-operation only by concentrating for a time on certain crops and showing by a good example.

Prof. T. J. Jenkins and Mr. G. Evans stressed the importance of reducing in cross-pollinated crops the number of generations between the basic plants of a strain and the seed as it reaches the user. When seed growers have gained more experience, they may be able to grow two generations from the seed released by the breeders rather than one as at present.

Mr. W. J. C. Lawrence asserted that, owing to piecemeal breeding with horticultural crops in the past, only some four instances could be cited where introductions by the research stations had materially affected crop production. What was needed was a policy of breeding and co-ordination which integrated the breeding with other aspects of production, such as climate, husbandry, markets, the consumer and future developments.

In the absence of Dr. P. S. Hudson, a talk on the Food and Agriculture Organisation Scheme for Cataloguing and Maintenance of Stocks was given by Dr. O. H. Frankel. The scheme provides for: (1) a catalogue of genetic stocks starting with self-fertilizing crops; (2) each country to be responsible for assembly, description, maintenance and distribution of its types; (3) descriptions to be collected by the Organisation, recorded on punched cards and published in lists. Points of detail in the scheme were criticized by Dr. Frankel, who stated that it made no provision for world collections, and by Dr. Harland, who pointed out that the most needed material came from primitive countries without plant breeders and that these would not be included in the scheme. Dr. Bell proposed the motion, which was carried unanimously, that although the Conference appreciated the deficiencies of the scheme it welcomed these steps towards making a world wheat catalogue.

New Tools

Mr. H. L. Fyfe made a plea for work on polyploidy and induced mutation in plant breeding. Much work had been done in Sweden to exploit these possible tools in plant breeding. But, apart from reduced fertility in polyploids, no predictions of the kind of effects produced could be made. It was too early to assess their value. But unless work was started in Britain we might find that we should be far behind. Mr. M. B. Crane emphasized the valuable results that could be obtained, quoting work done on horticultural crops in Denmark and on forest trees in Sweden. Dr. Catcheside pointed out that most X-ray mutations were deleterious loss changes; Dr. Lewis, confirming this, stated that X-radiation was the ideal tool to destroy a gene of which the breeder wished to rid his material. Examples were self-incompatibility in fruit, vigour in rootstocks and fertility in some ornamental crops. Dr. C. D. Darlington suggested that new polyploidy was more likely to be of value in previously unselected plants.

Dr. P. T. Thomas urged the need for cytological guidance in plant breeding, pointing out with examples how the cytologist can help the breeder. Diploid types had been found in the tetraploid wild white clover, and these might be of great value for synthesizing new types. In oats the segregation of sterile dwarf plants was correlated with changes in chromosome number. The cytologist was also of assistance when dealing with improvement by intra-species crossing and with crop plants which were already high polyploids in resynthesizing polyploids from wild types.

Resolutions

Oil Crops. Considering that in the attempt to acclimatize new oil crops in Great Britain, the full extent of natural genetic diversity is a first condition of success; and considering that such possible crops as sunflowers and soya beans manifest a diversity so far unknown in Great Britain, the conference recommended the Agricultural Research Council to make provision for the establishment of world collections of these and other important economic crops.

This was proposed by Prof. K. Mather, seconded by Mr. E. S. Bunting, and carried unanimously.

Forestry. Considering that with the use of modern genetical technique the productivity of the forest trees could be raised in Great Britain by at least 20 per cent; and considering the increasing scarcity of timber in this and other countries and that many other countries (such as Sweden, Denmark, South Africa and the United States) have already established first-class institutes for the study of tree breeding, it was recommended that the Agricultural Research Council should establish a forestry genetics institute for the improvement and acclimatization of forest trees by genetic methods.

This was proposed by Mr. M. B. Crane, seconded by Colonel F. C. Stern, and carried unanimously.

Teaching. Since there is a lack of persons in Great Britain with the training in pure and applied genetics necessary for the immediate and future tasks of plant breeding, and considering that this lack is due to the inadequacy of facilities for university teaching, most universities still having none whatever, many years after the need has become evident, the Conference urged that the Agricultural Research Council and the University Grants Committee should combine in taking steps to establish adequate genetics departments in all universities and university colleges.

This was proposed by Dr. J. Philp, seconded by Dr. G. D. H. Bell, and carried unanimously.

Seed Distribution. Considering the importance of the way in which new varieties of seed are distributed from plant breeders, the Conference recommended that the Agricultural Research Council should convene a joint meeting of plant breeders under its control, representatives of seed firms and the National Institute of Agricultural Botany to consider their common interests in this field.

This was proposed by Dr. A. J. Bateman, seconded by Mr. J. L. Fyfe, and carried unanimously.

Soviet Biology. Considering that world science needs the co-operation of gifted men of science in all countries, and that in the past the Soviet Union has made contribution to genetics of value to the whole world, the Conference deplored the dismissal of leading Soviet geneticists during the last ten years which has culminated in the official repudiation of the established principles and practices of genetics by the Soviet Government.

This was proposed by Dr. S. C. Harland, seconded by Dr. O. H. Frankel; it was carried by fifty-four to one.

D. Lewis

NEWS and VIEWS

New Year Honours List

THE following names of men of science and others associated with scientific work appear in the New Year Honours List:

Baron: Sir John Boyd Orr, lately director-general of the Food and Agriculture Organisation of the United Nations.

Privy Councillor: Lord Hailey, chairman of the Colonial Research Committee, for services to the Colonial Empire.

G.C.B.: Sir Henry Tizard, chairman of the Defence Research Policy Committee, Ministry of Defence.

G.B.E.: Sir Wilson Jameson, chief medical officer, Ministry of Health and Ministry of Education.

D.B.E.: Miss Myra Curtis, principal of Newnham College, Cambridge, and lately chairman of the committee on children deprived of a normal home life.

Knights: Prof. J. D. Beazley, professor of classical archæology, University of Oxford; Prof. H. Cohen, professor of medicine, University of Liverpool; A. J. Gill, assistant director-general (engineering), and engineer-in-chief since 1947, of the General Post Office; Dr. H. L. Guy, chairman of the Mechanical Engineering Research Organisation, Department of Scientific and Industrial Research; Dr. W. G. Ogg, director of Rothamsted Experimental Station; Dr. R. E. Priestley, vice-chancellor of the University of Birmingham; Dr. J. L. Simonsen, director of research, Colonial Products Research Committee; Prof. S. A. Smith, dean of the Faculty of Medicine and regius professor of forensic medicine, University of Edinburgh; W. L. Taylor, lately director-general of the Forestry Commission; Capt. F. O'B. Wilson, chairman of the Board of Agriculture, Kenya.

C.B.: Air Commodore A. H. Robson, director of educational services, Air Ministry.

C.M.G.: V. Boyle, superintending inspector, Animal Health Division, Ministry of Agriculture; Brigadier M. Hotine, director of Colonial Surveys, and adviser on surveys to the Secretary of State for the Colonies; Dr. J. M. Stewart, formerly vice-chancellor of the University of Adelaide.

C.B.E.: B. C. Aston, of Wellington, New Zealand, for services to agriculture and botany; O. V. S. Bulleid, chief mechanical engineer, Southern Region, Railway Executive; Prof. J. B. Cleland, formerly professor of pathology, University of Adelaide; F. S. Collier, chief conservator of forests, Nigeria; Colonel W. C. Devereux, managing director of Aluminium, Ltd., and chairman of International Alloys, Ltd.; I. G. Evans, assistant secretary, Department of Scientific and Industrial Research; Dr. J. Hammond, reader in agricultural physiology, University of Cambridge; J. McDonald, director of agriculture, Cyprus; Prof. F. H. Newman, professor of physics, University College of the South-West of England, and chairman of Exeter Joint Recruiting Board; Miss M. H. Read, head of the Colonial Department, Institute of Education, University of London; Lieut.-Colonel W. Campbell Smith, deputy chief scientific officer and keeper of mineralogy in the British Museum (Natural History); Dr. O. J. Voelcker, director of the West African Cacao Research Institute; Prof. W. Wardlaw, professor of physical chemistry, University of London (Birkbeck College), scientific adviser, Appointments Department, Ministry of Labour; R. T. B. Wynn, assistant chief engineer, B.B.C.

Sir C. V. Raman, F.R.S.

SIR C. V. RAMAN has been appointed the first National Research Professor in India; he has just retired from his professorship at the Indian Institute of Science in Bangalore. It is expected that he will take up his new duties immediately and will work at the newly founded Research Institute under the auspices of the Indian Academy of Sciences at Bangalore. This appointment is the first of its kind in India. Sir C. V. Raman is known particularly for his work on the molecular scattering of light, whereby the frequency of incident radiation is changed by an amount characteristic of the scattering compound. This had been predicted on theoretical grounds, but it was first observed by Raman and is generally known as the 'Raman effect'. It has proved of great interest and importance in studying the theory of the structure of chemical compounds. Among the many honours received by Sir C. V. Raman are the Nobel Prize for Physics (1930), Hughes Medal of the Royal Society (1930), and the Franklin Medal of the Franklin Institute, Philadelphia (1942).

Progress Medal of the Photographic Society of America: Dr. C. E. K. Mees, F.R.S.

THE first presentation of the Progress Medal of the Photographic Society of America was made, during the Society's 1948 Convention held in Cincinnati, to Dr. C. E. Kenneth Mees, vice-president in charge of research of the Eastman Kodak Company, in recognition of his contributions to photography—technical, literary and inspirational. Dr. Mees delivered the Society's first Progress Medal Lecture, dealing with the work of the Kodak Research Laboratories. Emphasizing the spirit of freedom in the Laboratories, he said: "When the scientist selects a field of work, he is left free to exploit it as he sees fit. No attempt is made to anticipate scientific discoveries that may be made, or to regulate or organise the direction which the work may take." He traced the growth and achievements of the Laboratories, mentioning studies from 1920 onward of the physical chemistry of gelatin and the crystalline structure of the silver halides, important to photographic emulsions. He described the discovery in 1925 of the sensitizing action of gelatin for silver bromide. The chemistry of development, sensitometry, the psychophysics involved in viewing photographs, and granularity and graininess of photo materials were among the topics discussed. The largest single division of the Laboratories, he said, is that devoted to the making of photographic emulsions, both for film and paper. The emulsion laboratories have also done important work on optical sensitizing dyes, which brought rapid changes in photographic materials between 1925 and 1935.

Agricultural Advisers to United Kingdom High Commissioners in Australia and New Zealand

THE Agricultural Departments and the Commonwealth Relations Office announce the appointment of Mr. C. W. Strutt and Mr. D. S. Hendrie to be agricultural advisers to the United Kingdom High Commissioners in Australia and New Zealand, respectively. These are new appointments, although a similar post has existed in Canada for some time.

Mr. C. W. Strutt, who was born in 1902, was brought up on his father's mixed farm in Sussex. He studied at the South Eastern Agricultural College,

Wye, and after graduation he remained at the College for a year as a lecturer in agricultural chemistry, before going as head of the Advisory Department at Messrs. Fostock, Ltd., Welwyn Garden City. Later he became superintendent and technical adviser to Messrs. R. Silcock and Sons, Ltd., and from September 1945 was attached to the Animal Nutrition Institute, Cambridge. He was appointed to the staff of the Ministry of Agriculture and Fisheries in 1946, as a livestock husbandry advisory officer of the National Agricultural Advisory Service. He was lent to the Ministry of Food to take part in the recent Government food mission to Australia under the chairmanship of Sir Henry Turner.

Mr. D. S. Hendrie is thirty-nine years of age. He studied at the University of Glasgow and West of Scotland Agricultural College, and later at the School of Agriculture, Cambridge, and Ontario Agricultural College. During 1932–36 he was an assistant lecturer and assistant farm manager to the West of Scotland Agricultural College, and in 1936 became district lecturer to the University of Leeds. In 1940 he was seconded to the Yorkshire (North Riding) War Agricultural Executive Committee as executive officer. He was appointed to the staff of the Ministry of Agriculture and Fisheries in 1946, being made county agricultural officer for the North Riding.

Central Committee for Adult Education in H.M. Forces

Mr. E. C. Read, senior lecturer in education, University College, Hull, has been appointed secretary to the Central Committee for Adult Education in H.M. Forces, the body representing the universities, local authorities, and voluntary organisations which succeeds the Central Advisory Council. Dr. Basil A. Yeaxlee and Miss M. E. Holloway, who served the Council from its inception in January 1940 until its transformation last June into the Central Committee, will continue as acting secretary and deputy secretary respectively until Mr. Read takes office on April 1. Prof. Robert Peers, deputy vice-chancellor of the University of Nottingham and professor of adult education, is chairman of the Central Committee, succeeding Sir Walter Moberly, who was chairman of the Central Advisory Council.

A statement made in the House of Commons on December 17 by the Minister of Defence spoke of the great value attached by the Government to the co-operation of the civilian educational bodies with the Services during and since the War, and of the Government's satisfaction that this has now been put on a permanent basis. Fourteen universities and university colleges have consented to establish in their areas representative committees replacing the old *ad hoc* regional committees, and in the remaining areas the universities will continue, without special organisation for the purpose, to secure for the Services such assistance as may be requested. The universities have, of course, made it a condition that they shall not be directly responsible for the work of less than university extra-mural standard and that the administrative and educational cost shall be defrayed from Government sources. A large proportion of the work will be appropriate to local education authorities and voluntary bodies such as the Workers' Education Association and the Y.M.C.A., but this will all form part of the annual programme agreed upon with the Services in the area and co-ordinated and financed through the university committees.

Eels and their Environment

In 1937 Dr. G. D. Athanassopoulos, professor of zoology in the University of Thessaloniki (Greece), reported that elvers and very young eels kept for a few days, or at times for only a few hours, in the tanks of fish-culture stations in Italy, developed small blisters in their head regions (*Internat. Rev. Ges. Hydrobiologie und Hydrographie*, **36**, 218; 1937). Later he observed the same kind of blisters on elvers and very young eels in Greece. At first he believed this blistering to be caused by the water in the tanks becoming too warm, and attempted to prevent its occurrence by improving the flow of running water to the tanks in which the eels were kept. To his surprise, however, this treatment notably increased the incidence of blisters which, on examination, were found to contain atmospheric air. Further investigation revealed that the causative factor was excessive aeration of the water. The vesicles arise chiefly on the head, but occur also on other external surfaces of the body and even internally. They soon become centres of infection by bacteria and protozoa.

Satellites of Uranus

W. H. Steavenson has given the results of his observations of the four chief satellites of Uranus (*Mon. Not. Roy. Ast. Soc.*, **108**, No. 2; 1948) and has arrived at some interesting conclusions. Using his 30-inch reflector between January 9, 1947, and April 8, 1948, his observations of the position-angles of Umbriel, Titania and Oberon showed that there were no appreciable errors in their computed longitudes, so that the assumed periods of these three satellites are correct, or if there are discrepancies they must be very small. In the case of Ariel, the discrepancy between theory and observation of the hour-angle indicated that a correction of + 6·1° to the computed longitude was necessary. The epoch of Newcomb's orbit is 1872·0, from which it is deduced that the old period should be decreased by 0·34 sec. —a small error considering the shortness of the time between the discovery of the satellite and Newcomb's computation of its orbit. The period of Ariel, applying Steavenson's correction, is now 2·5203796 days. Revised magnitudes of the satellites are given, and the following magnitudes, which are not based on photometric measures but on Steavenson's familiarity with the North Polar Sequence and the fields of numerous variable stars, are closer to the truth than those usually given: Oberon, 13·8; Titania, 13·7; Umbriel, 14·5; Ariel, 13·7. The satellites are brighter than has been generally assumed by 0·2, 0·3, 1·5 to 2·5, and 2·7 magnitudes, respectively. In the case of Titania and Oberon, Steavenson found decided changes in magnitude from night to night during his observations, and the variations seem to indicate that the axis of rotation of one or both of the satellites makes a large angle with the normal to the orbit-plane and may even lie in or at least close to that plane.

India Society of Engineers

In July the *Journal of the India Society of Engineers*, first published in 1935, appeared under the new title *Science and Engineering*; its content, which has always consisted almost exclusively of descriptive comment on the Indian industrial outlook and events, remains unchanged. The altered name is intended to signify a break with the past and to symbolize the fact that India is now controlled by

an independent administration. It is difficult to judge any Eastern publication by Western standards: the printing and lay-out of the present journal are certainly not good. Despite their shortcomings, however, these publications are valuable, for it is through such organs that Indian engineers are kept in touch with local progress in industrial practice and, when they enter the industrial field, with scientific developments as well.

Post-doctorate Fellowships in Canada

Some forty post-doctorate fellowships will be awarded by the National Research Council, Canada, in 1949–50 for research in pure chemistry and physics. The fellowships will be tenable in the National Research Council laboratories at Ottawa and in the laboratories of the Atomic Energy Project at Chalk River, Ontario. There will be about twenty awards in chemistry, fifteen in physics and about six in atomic energy research. Fellowships are tenable for a period of one year but may be renewed for a second year upon application. The stipend is 2,820 dollars per annum and is free of income tax. A grant-in-aid of expenses will be made to persons from outside Canada, and a similar grant may be made on the termination of the fellowship. There are no restrictions as to the nationality of the applicant in the case of the Ottawa laboratories; but appointments at Chalk River are restricted to British subjects. Applications should be received at the National Research Council, Ottawa, not later than March 1, 1949, for this year's awards.

Swedish Society for Clay Research

A Swedish Society for Clay Research was constituted at a meeting at Höganäs, Sweden, on November 4, when representatives of geology, mineralogy, chemistry, soil science, ceramic industries, geotechnology, etc., were present. The Society will keep in contact with the International Committee for Clay Studies (Comité International pour l'Étude des Argiles) formed in London last August. The following have been appointed members of committee of the new Swedish Society: Dr. G. Assarsson, of the Geological Survey, Stockholm (chairman); Dr. L. Silfverberg, of the Royal Swedish Geotechnical Institute, Stockholm (honorary secretary); E. Forslind (Swedish Cement and Concrete Research Institute, Stockholm); Dr. Rolf Norin (Höganäs), and Dr. Lambert Wiklander (Institute for Pedology, Ultuna, Uppsala).

Sheffield Library: Technical Bibliographies

The Sheffield City Libraries have prepared fifty-four bibliographies on a range of subjects in the fields of chemical and industrial engineering, metallurgy, and physical chemistry, with particular emphasis on the steel and metallurgical industries in Sheffield. Since the number of copies is limited, the City Librarian states they can be sent only to research workers or responsible works executives, and all inquiries should be addressed to him at the Administration Department, Central Library, Sheffield, 1.

British Rheologists' Club

At the annual general meeting of the British Rheologists' Club, held at the Institute of Physics on October 29, 1948, the following officers were elected for the ensuing year: *President*, Prof. N. F. Mott; *Hon. Secretary*, Dr. E. W. J. Mardles; *Hon. Treasurer*, Dr. V. G. W. Harrison; *Hon. Auditor*, Mr. A. de Waele. The following were also elected to the Committee: Dr. A. H. Nissan; Dr. J. G. Oldroyd; Dr. G. W. Scott-Blair (*editor*); Mr. M. W. Thring; Mr. A. G. Ward (*chairman*); and (co-opted to represent the North of England) Mr. W. A. Richardson.

Education for Family Life

"Education for Family Life" is to be the theme of the planning forum which the British Social Hygiene Council is arranging on January 26, at 6.15 p.m., at the Planning Centre, 28 King Street, Covent Garden, W.C.2. This meeting is the second in a new series of forums which are to be held at fortnightly intervals during the period January–March under the auspices of a group of voluntary societies engaged in social work. Mrs. Eva Hubback, principal of Morley College and chairman of the Education Committee of the London County Council, will be in the chair, and those taking part in the forum will be Dr. Letitia Fairfield, Dr. Ethel Dukes and Mr. Geoffrey Martin. Time will be allowed for discussion. Further information and tickets (price 1*s.*) can be obtained at the door, or from the Planning Centre, 28 King Street, Covent Garden, London, W.C.2.

University of London

The following appointments in the University of London have been announced:

Dr. C. B. Allsopp, to the University readership in physics tenable at Guy's Hospital Medical School; Dr. C. K. Simpson, to the part-time University readership in forensic medicine tenable at Guy's Hospital Medical School.

The following have been appointed readers in respect of the posts now held by them: Dr. W. E. Duncanson, University College (physics); Dr. D. B. Fry, University College (experimental phonetics); Dr. O. H. K. Spate, London School of Economics (geography); Dr. Andrew Wilson, University College and University College Hospital Medical School (applied pharmacology).

Announcements

The Federal Council of the Australian Institute of Agricultural Science has awarded its Medal for 1949 to Prof. W. L. Waterhouse, of the University of Sydney. The award is made for the most outstanding service to Australian agriculture during the preceding ten years.

The former Institute of Physical and Chemical Research, Komagome, Tokyo, has been dissolved and the work taken over by the Scientific Research Institute, Ltd., at the same address. Its publications, the *Scientific Papers* and the *Bulletin* of the Institute, have been renamed the *Journal* and the Reports of the Scientific Research Institute.

Volume 30 of the *Transactions of the British Mycological Society* is a jubilee volume which places on permanent record the papers presented at the commemorative meeting in London during October 20–25, 1946. These deal with the Society's history, and with various facets of modern mycology; a full review of their contents appeared earlier in *Nature* (158, 693; November 16, 1946).

Erratum. In "Regenerated Keratin Fibres" by Dr. R. L. Wormell and Dr. F. Happey in *Nature* of January 1, p. 18, in the legend to the figure, last line, for $D = 3$ cm. read $D = 4$ cm.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

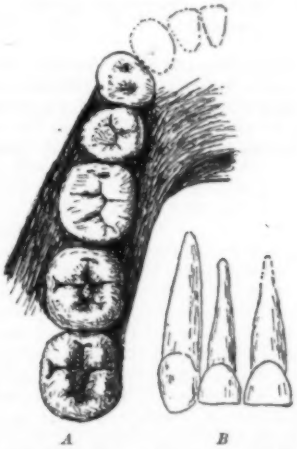
Another New Type of Fossil Ape-man

SOME years ago, I pointed out that in my opinion the cave deposits in the dolomite of the Transvaal when fully worked will give us the remains of most stages of early man and pre-man that have inhabited South Africa from probably Middle Pliocene to Recent. In the Sterkfontein area alone there are apparently in about ten square miles more than a hundred different cave deposits, and many of these are of quite different ages judging by the faunas. Almost all the animals at Kromdraai main deposit are quite different species from those at the main quarry at Sterkfontein. The jackals, the sabre-toothed tigers, the baboons, the dassies and the ape-men are quite different species.

At the beginning of November we started work at a new spot in association with the California University Expedition. Though the deposit is on the farm Swartkrans and only a mile from the main Sterkfontein quarry, the fauna so far as we have gone proves to be very different—whether older or younger we cannot yet say. Luckily we found teeth of a new type of ape-man within ten days, and a week later discovered much of a mandible with the complete lower premolars and molars.

The new mandible is not closely allied to that of the Sterkfontein ape-man *Plesianthropus*; the teeth are allied to those of the Kromdraai ape-man *Paranthropus*; but they are much larger and differ in a number of respects.

We have found two beautiful upper incisors and a perfect upper canine. These teeth are almost typically human, though a little larger than most human teeth. The canine has no deep infolding of the enamel on the lingual side as we have in the canines of *Plesianthropus*. It is also interesting to note that the canine and the 2nd incisor have been in contact, as each has been abraded by the other.



A *B*

Teeth of *Paranthropus crassidens* Broom. ⅔ Natural size. *A*. Left mandibular ramus. The 1st premolar is a little displaced in the specimen and has been restored to its natural position. The 3rd molar is drawn from the 3rd right molar reversed. *B*. Right upper incisors and canine

The mandible was found in the same deposit but at a spot about 10 ft. from the isolated upper teeth, and it cannot belong to the same individual though it is clearly of the same species.

The mandible is very massive. The horizontal ramus is preserved from the 2nd premolar to the 2nd molar; the 1st premolar is also preserved but a little displaced. Most of the inner side of the symphysis resembles more closely that of the Heidelberg jaw than any other specimen of man or ape-man I know.

But the teeth are relatively huge. The drawing is of the occlusal view with the 1st premolar in position, and the left 3rd molar drawn from the right tooth reversed.

This new type of ape-man is not closely allied to either *Australopithecus* or *Plesianthropus*, but is allied to *Paranthropus*. When a skull is discovered it may prove to belong to a new genus; but provisionally we may call it *Paranthropus crassidens*.

As further evidence of the richness of our deposits, attention may be directed to the wonderful finds being made in the northern Transvaal at the Makapan caves. For about a couple of years the Bernard Price Institute has been working there, and Prof. R. A. Dart has recently announced the discovery of a remarkable ape-man occiput, and a few weeks later of a very fine mandible. These he has referred to a species of *Australopithecus*, and has called the animal *A. prometheus*. Though I am not convinced that he made fire, I am of opinion that the being belongs not only to a new species but also to a new genus. Prof. Dart has some other most important remains which he is describing. But I feel at liberty only to refer to what has been already announced.

R. BROOM

Transvaal Museum,
Pretoria. Dec. 7.

Exchange Integral with 3*d* Wave-Functions

PRECISE calculations have been carried out of the exchange integral occurring in a first-order perturbation calculation of molecular energies on the basis of the Heitler–London treatment. The wave-functions used for the two separate atoms were of the 3*d* hydrogenic type, but having spherical symmetry,

$$\psi = Nr^2 \exp(-\alpha r), \qquad (1)$$

N being a normalizing factor appropriate to a charge distribution which is an average over the five degenerate m_l states. Calculations have been made for effectively the whole range of internuclear distances, and it is found that the exchange integral is negative over nearly all the range for which the first-order perturbation calculation gives a reliable approximation. Additional calculations of the Coulomb integral show that the energy of the $^1\Sigma$ state is always lower than that of the $^3\Sigma$ state, that is, that the total spin in the ground-state of the molecule is zero.

The importance of these calculations lies in their relevance to ferromagnetism, which is in general to be ascribed to a positive interaction between 3*d* electrons[1]. Previous qualitative discussions by Heisenberg[2], Slater[3] and Sommerfeld and Bethe[4] have suggested that, with a fairly large internuclear separation, a strong overlap of wave-functions in the internuclear regions and a weak overlap near the nuclei should lead to a positive exchange integral, and that the conditions for a positive sign are likely to become more favourable as the orbital quantum

number increases from $l = 0$ (for which Sugiura[5] obtained a negative result) to $l = 2$. The present calculations show that the dependence of the sign of the exchange integral on l and the internuclear distance is not as simple as was previously supposed, a negative integral being obtained even with $3d$-type wave-functions. Calculations due to Bartlett[6], on the other hand, have shown that a positive integral may be obtained with $2p$-type wave-functions. Bartlett found that the two lowest molecular energy states here arise from atomic wave-functions of the form

$$\psi = Nr \exp(-\alpha r) \cos\theta, \qquad (2)$$

for which $m_l = 0$, the $^3\Sigma$ state being lower than the $^1\Sigma$ state. These wave-functions have angular nodes which pass through the nuclei and are perpendicular to the line joining them, and, as pointed out by Sommerfeld and Bethe[4], the negative contributions to the exchange integral are thereby much reduced and the positive contributions enhanced. It appears, therefore, that with a given radial wave-function the sign of the exchange integral may be markedly dependent on the angular wave-function.

It is very probable[7] that with $3d$-type wave-functions, also, the lowest molecular energy states arise from atomic states for which $m_l = 0$. An appropriate wave-function in this case is

$$\psi = Nr^2 \exp(-\alpha r) P_2(\cos\theta), \qquad (3)$$

with two angular nodes which are again favourable to a positive exchange integral. For higher states, and non-zero m_l values, the atomic wave-functions are less likely to lead to a positive integral, and the integral which has been calculated on the basis of (1) may be regarded as an average value over all the possible energy states of the molecule.

The dependence of the exchange integral on the angular wave-function, and the bearing of the results on the conditions for ferromagnetism in solids are at present being investigated. My thanks are due to Prof. E. C. Stoner for suggesting these calculations and for his helpful advice, and to the Department of Scientific and Industrial Research for a grant.

E. P. Wohlfarth

Physics Department,
University, Leeds.
Sept. 21.

[1] See, for example, Stoner, E. C., "Phys. Soc. Rep. Prog. Phys.", **11**, 43 (1948).
[2] Heisenberg, W., *Z. Phys.*, **49**, 619 (1928).
[3] Slater, J. C., *Phys. Rev.*, **35**, 509 (1930).
[4] Sommerfeld, A., and Bethe, H., "Handb. d. Phys.", **24/2**, 595 (1933).
[5] Sugiura, Y., *Z. Phys.*, **45**, 484 (1927).
[6] Bartlett, J. H., *Phys. Rev.*, **37**, 507 (1931).
[7] Slater, J. C., *Phys. Rev.*, **38**, 1109 (1931).

Photographic Record and Diagrams of Luxembourg Effect with Resonance (Gyro-Interaction)

After the results obtained during the gyro-interaction investigations of 1946 and 1947 [1], the Istituto Elettrotecnico Nazionale G. Ferraris of Turin and the Institute of Technical Physics of the University of Naples, in association with the Italian Navy, Air Force, Army, Vatican Radio and R.A.I., carried out during May 12–June 8 a third series of experiments in order to measure the depths of parasitic modulation obtained using a disturbing wave the frequency of which was equal to the local gyro-frequency.

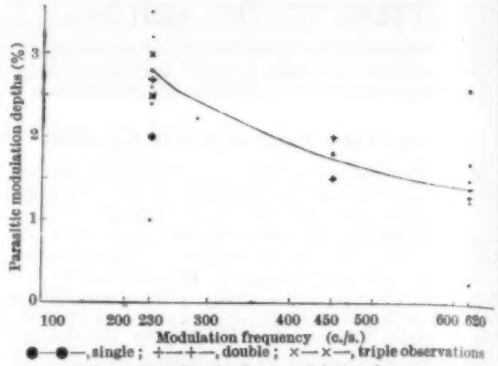
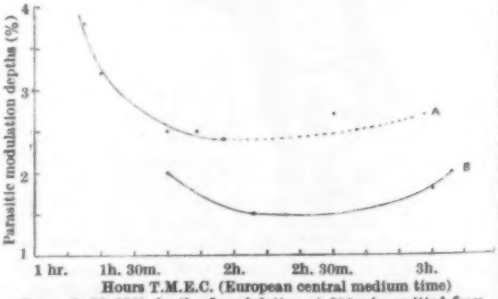


Fig. 1. Parasitic depth *v.* modulation frequency

The stations of Taranto (618 m., 1 kW.), Augusta (550 m., 1 kW.) and Palermo (531 m., 8 kW.) operated as 'wanted' stations, and Leghorn, La Spezia, Venice and Cagliari as control receiving stations. Vatican Radio operated as disturbing station emitting a fixed frequency (266 m., 5 kW.) equal to the gyromagnetic frequency. The modulation frequency of Vatican Radio varied from 230 to 650 c./s. The measuring apparatus for very small depths of modulation was located in Turin in the Istituto Elettrotecnico Nazionale, and consisted of a sensitive receiver with two oscillographs inserted respectively on medium frequency stages and audio-frequency output and in narrow-band acoustic filters to eliminate statics and noise; two standard radio-frequency and audio-frequency generators were used for the calibration and the depth of modulation measurements.

The effect was observed on each of the 'wanted' wave-lengths; but it was recorded only on the wave-length of Taranto. The depths of parasitic modulation varied between 0·25 and 3 per cent (with maximum error of 10 per cent), as shown in Fig. 1, which indicates also that parasitic modulation varies with the modulation frequency according to V. A. Bailey's theory[2]. Fig. 2 shows that the parasitic depth for the same modulation frequency depends on the time. It confirms earlier observations[1] that as time increases the resonance wave-length moves from 266 m.

The emission frequency of Vatican Radio being equal to the gyro-frequency, the difference of radiated power between Taranto and Vatican and the narrow-band filters of the receiving station of Turin have so much increased the phenomenon that for the



Curve *A*, 30–35% depth of modulation at 230 c./s. emitted from Vatican Radio; curve *B*, 35% depth of modulation at 450 c./s.

Fig. 2. Parasitic depth *v.* time.

Fig. 3

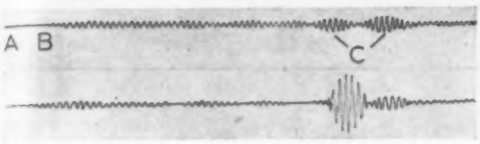


Fig. 4

Fig. 3. The parasitic modulation observed on the wave of Taranto. Between *A* and *B* Taranto emitted, but Vatican Radio stopped. In *B* Vatican Radio began the emission of the long dash. *C* are statics

Fig. 4. Record of the *X* (— . . —) emitted by Vatican Radio, and observed on the wave of Taranto. The first dash and the two dots are clearly distinguished; the second dash is partially covered by statics

first time we have been able to make a photographic record of oscillograms of gyro-interaction. Fig. 3 is a drawing of the oscillogram of the receiver output reproducing the Vatican modulation superimposed on the Taranto wave (parasitic depth about 3 per cent). Fig. 4 is a drawing of a film exposed during the night on June 8: Vatican Radio emitted, at 230 c./s. modulation frequency, dashes of 10 sec. divided by two slow *X*'s (— . . —). Fuller accounts of this work will shortly be published in *Alta Frequenza*.

We express our indebtedness to Profs. G. C. Vallauri, E. Carlevaro, A. Pinciroli for their assistance; to Drs. L. Licastro and M. Carlevaro for their co-operation in mounting the apparatus; and to Mr. P. Mirabella for his co-operation in the observations and for the oscillographic record.

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July 24.

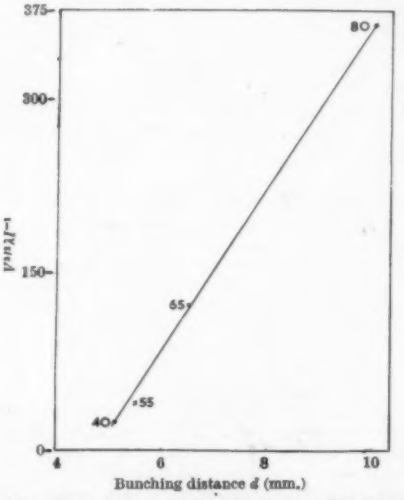
[1] *Alta Frequenza*, **15**, No. 2, 111 (1946); *Nature*, **160**, 834 (1947).
[2] *Phil. Mag.*, **18**, 369 (1934); *Nature*, **135**, 585 (1935).

Plasma-Electron Oscillations

IN a recent communication[1], Dr. E. B. Armstrong gave an account of some new facts concerning the oscillations with frequencies of order of 1,000 megacycles/sec. and upwards which are generated internally in a low-pressure hot-cathode discharge. In this he stated that it was probable that at least two processes were occurring, namely, a vibration of plasma-electrons in a small volume close to the cathode, and velocity modulation of primary electron beams passing through this.

In some fresh experiments using a specially designed tube with a straight wire filament and movable probes, containing mercury vapour at room temperature, further evidence for the occurrence of these processes has been found. By exploring the plasma with a probe coupled to an external co-axial resonator, bunching points have been located along the primary electron beams. If we assume that the plasma electrons are maintained in vibration in a region close to the filament and that the amplitude-frequency response of the crystal rectifying circuit is sensibly constant, then, from the Webster formula for first-order bunching[2], there should be a linear relation between distance *d* from the filament to the bunching point, and the bunching parameter $V^{3/8}\lambda I^{-1}$, if the tube voltage *V* is taken to measure the mean energy of the primary electrons, and the amplitude of response *I* of the resonator with the probe at the bunching point is taken to be proportional to the integrated amplitude of the modulating field; λ is the vacuum wave-length of the oscillations.

The accompanying graph shows a plot of *d* v. $V^{3/8}\lambda I^{-1}$ obtained when the mercury vapour pressure was 1·0 micron and the filament heating current 5·5 amp., which gave a saturated anode current of 55 milliamp. for $V \geqslant 38$ volts. The anode voltages in this set of observations ranged from 40 to 80, the wave-lengths from 21 to 28 cm., the bunching distances from 5 to 10 mm., and the response of the resonator at the bunching point changed by a factor of 7. The approach to linearity seems as good as could be expected with the approximations made, especially as the probe was moved along a line perpendicular to the filament, whereas the path of the primary beam is inclined at a small angle to this, due to the magnetic field of the filament-heating current. If the scattering of fast-electron energies determined from the probe characteristics is taken as a measure of the integrated modulating field, the Webster formula yields absolute bunching distances of the same order as the experimental value.



Test of bunching relation: *V* is in volts, λ in cm., *I* in microamp. The figures against the line are the values of *V* for the corresponding observations

By examining the response of the resonator when various static biasing potentials are applied to the probe, it has been found possible to distinguish between response due to coupling between this electrode and the modulated primary beam, and that due to vibrating plasma-electrons. In this way, the original oscillating sheet of plasma has been directly located close to the filament.

The work so far mentioned is in the main an extension of the pioneer work of Merrill and Webb[2]; but in addition some evidence has been obtained about the way in which plasma-electron vibrations are maintained. Briefly, maintenance appears to be effected by a mechanism analogous to that which operates for high-frequency oscillations in hard diodes due to electron transit-time effects. The prob-

able importance of electron transit-time in high-frequency phenomena in gaseous discharge tubes has already been indicated by, among others, Armstrong[1] and Schumann[4]. The anode of the hard tube, in this mechanism, is replaced by the plasma of the discharge, and the resonator by the oscillating sheet of plasma. Semi-quantitative agreement, with appropriate modifications of the theory for hard tubes, can be obtained if allowance is made for the fact that the boundary between the double space-charge sheath round the filament and the plasma is diffuse[5,6].

There are outstanding problems, some of which were referred to by Armstrong, which cannot obviously be accounted for in the present picture; but there appears to be no serious inconsistency between the relatively simple considerations advanced here, and the experimental data for oscillations of small amplitude, provided that the introduction of probes into the plasma does not modify fundamentally the natural oscillatory phenomena.

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Queen's University,
Belfast.
Sept. 1.

[1] Armstrong, E. B., *Nature*, **160**, 713 (1947).
[2] Webster, *J. App. Phys.*, **10**, 864 (1939).
[3] Merrill and Webb, *Phys. Rev.*, **55**, 1191 (1939).
[4] Schumann, *Z. Phys.*, **121**, 7 (1942).
[5] Tonks and Langmuir, *Phys. Rev.*, **33**, 954 (1929).
[6] Druyvesteyn and Warmoltz, *Physica*, **4**, 51 (1937).

Thermo-osmosis of Gases through a Membrane

Thermo-osmosis may be defined as the passage of a fluid through a membrane against the hydrostatic pressure, due to a temperature gradient. It was first observed by Lippmann[1] in the passage of water through membranes of gelatine, etc. The fact that temperature gradients are able to give rise to a flow of matter is shown also by such varied phenomena as the thermal effusion of a gas through a porous diaphragm, the fountain effect in helium II, and also (in multicomponent systems) by thermal diffusion and the Soret effect.

The phenomenon observed by Lippmann was complicated by the presence of electrolytes[2] and was not a pure thermo-osmosis. I have sought to discover such an effect by investigating the passage of a gas through a non-porous membrane in which it is slightly soluble. The experimental difficulty is the maintenance of an appreciable difference of temperature across a membrane thin enough to allow the passage of the gas at an observable rate. This was achieved by loosely pressing a rubber disk, 0·1 mm. thick, between two aluminium plates, sealed with 'Pycene' at the periphery. At the centre of each plate there was a small hole which allowed the thin layer of gas between the rubber and the metal to communicate with a vacuum system. The whole apparatus was supported in the dividing wall between two thermostat tanks, so that each metal plate was held at a constant temperature.

At a temperature difference of 5–10° C., it was found that carbon dioxide passed through the membrane at an appreciable rate and could be made to circulate continuously through a bubbler in an external circuit. The system is thus a heat engine, although of very low efficiency relative to the heat passing through the membrane by conduction. With no external circuit, the carbon dioxide passed through the membrane until a stationary pressure difference had been built up which was just sufficient to prevent any further flow. This pressure difference was measured for as long as a week and was entirely constant. Similar results were obtained with hydrogen, except that the flow was *in the reverse direction*, being in this case from warm to cold. The flow was also much slower and the final pressure difference was only about 30 per cent of that obtained with carbon dioxide and of opposite sign (cf. thermal effusion in a *porous* diaphragm where the flow is always from cold to warm).

It was shown by de Groot[3] that the following equation is applicable to thermal effusion and also to the fountain effect in helium II:

$$\frac{dp}{dT} = \frac{-Q^*}{VT}. \qquad (1)$$

Here dp is the stationary pressure difference due to a temperature difference dT, V is the molar volume of the migrating fluid, and Q^* is a non-classical heat effect, called the 'heat of transport'. The equation is not obtained from classical thermodynamics, since the system is not in equilibrium, but is derived on the basis of Onsager's reciprocity theorem in irreversible processes[4].

The preliminary experimental results indicate that this equation is satisfied also in the present effect. For a perfect gas, substituting $pV = RT$, the equation may be integrated over the finite temperature difference between the two surfaces of the rubber:

$$\log \frac{p_1}{p_2} = \frac{Q^*}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right). \qquad (2)$$

The results for carbon dioxide are given in the accompanying table and are in agreement with this equation, as shown by the constancy in the calculated value of Q^*. This value, however, is certainly too low, due to the fact that the temperatures, as measured by means of thermocouples in the aluminium plates, were not the true temperatures at the surfaces of the rubber membrane. Attempts are now being made to overcome this difficulty and also to extend the range of temperatures and pressures.

Pressure (mm. Hg)		Temp. (° Abs.)		Q^* (cal./mole)
p_1	p_2	T_1	T_2	
792·10	781·56	305·0	297·2	−310
788·73	782·57	306·7	302·0	−308
466·62	463·15	306·6	302·1	−306
252·61	248·57	307·5	298·0	−309

It is of interest that three processes so diverse in their kinetic mechanism may all obey the same thermodynamic expression. It remains to be seen whether the thermo-osmosis is entirely due to the effect of temperature on the solubility of the gas in the rubber, or whether there is also a thermal diffusion process inside the membrane.

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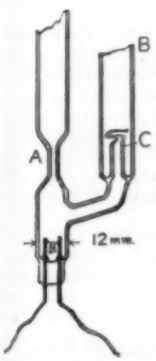
July 5.

[1] Lippmann, *C.R. Acad. Sci., Paris*, **145**, 104, 105 (1907).
[2] Aubert, *Ann. Chim. Phys.*, **26**, 145, 551 (1912). Also, Freundlich, "Colloid and Capillary Chemistry", 272 (1926).
[3] de Groot, *J. de Phys. et Le Radium*, **8**, 188 (1947); *Physica*, **13**, 555 (1947). Also Derjaguin and Sidorenkov, *C.R. Acad. Sci., U.R.S.S.*, **32**, 622 (1941). For review see Hutchison, Nixon and Denbigh, *Trans. Farad. Soc.*, Discussion No. 3, 86 (1948).
[4] Onsager, *Phys. Rev.*, **37**, 405 (1931); **38**, 2265 (1931).

Microsynthesis of C^{14}-Labelled Ethylmagnesium Iodide

THE synthesis of C^{14}-labelled ethyl iodide on the 10–15 micromole scale has been described[1], the scale being chosen so that high specific activity $C^{14}O_2$ could be used undiluted as starting material. The product would then contain about 6 microcuries of carbon-14 per micromole. On about the same scale, radioethyl iodide can without dilution be converted to radioethylmagnesium iodide by reaction in ethereal solution with a magnesium mirror.



The reaction is carried out in a small vessel as shown in the accompanying figure. This reaction vessel is attached to the high-vacuum apparatus; it has a platinum filament on which is hung a small piece of magnesium ribbon. The vessel is dried thoroughly by baking out at 300° C. under vacuum for a total of about thirty hours, and a mirror is then thrown up on the walls of the tube by heating the filament electrically. About 150 standard microlitres of dry radioethyl iodide vapour are condensed in, followed by 10 standard millilitres of very carefully dried diethyl ether vapour, after which the vessel is removed from the apparatus by sealing off at *A*.

The best yield of the Grignard reagent which has been found is about 55 per cent, and this is obtained by incubating the contents of the reaction vessel at 37° C. for two hours: shorter or longer periods of incubation give lower yields for reasons not ascertained. Yield is determined by measuring the ethane formed on decomposition with water. This is done immediately after incubation by resealing the reaction vessel to the apparatus at *B*, breaking the seal *C*, distilling off ether and unreacted ethyl iodide and then condensing water vapour on to the dry residue. The radioethane is purified by a standard technique and, after measurement in a McLeod gauge, is counted in a Brown and Miller type β-counter without first burning to carbon dioxide, as the amount is small and there are no losses due to adsorption on the counter walls.

The specific activity of the ethane is always that expected from the known specific activity of the radioethyl iodide used, indicating that in the conditions of these experiments there is no exchange between the ethyl group of ethyl iodide and those of diethyl ether.

We wish to acknowledge grants from the Therapeutic Research Corporation, the Royal Society and the Central Research Fund of the University of London, and to thank the Medical Research Council for grants and for radiocarbon. One of us (R. G.) is a Keddey Fletcher-Warr student of the University of London.

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[1] Arrol and Glascock, *Nature*, **161** 932 (1948).

Poisoning in High-Vacuum Oxide-Cathode Valves

IN the course of our investigations into the causes of deterioration of emission from oxide cathodes, we have noticed a phenomenon of possible significance. The phenomenon has been found to be common to a variety of tubes, including commercial pentodes and valves prepared in our own laboratory. A full investigation will be published in due course; but it is felt that a note at this stage might interest some readers.

It is fairly generally accepted that the life of an oxide-cathode valve is a function of the cathode loading, that is, the current density drawn through the cathode. An inference frequently drawn is that the magnitude of the current traversing the cathode is a direct factor in decreasing the emission of the cathode during life by electrolytic removal of active barium or some other mechanism. Our own conclusion is somewhat different, and follows the line that the magnitude of the current is of little importance within fairly wide limits; but that the ionizing action of the current *after* leaving the cathode surface is the prime factor leading to cathode deterioration. An illustration may help to make clear our meaning.

A commercial high-slope oxide-cathode pentode valve type with a known life of 500–1,000 hr. was selected for the experiment. Two batches of eight valves each were taken at random and placed on life-test in the following manner. Tubes of batch *A* were arranged as diodes with control grids acting as collectors and a positive voltage (approximately 2 volts) applied between grid and cathode to give a cathode current of approximately 12 mA. Tubes of batch *B* were arranged as triodes with anodes strapped to screen and suppressor grids and primed with 200 volts. Control grid voltages of the triodes were adjusted to allow each tube to pass 6–8 mA. Cathode temperatures of both batches were maintained at a nominal 1,000° K. Life-test of the valves showed that the diode-connected batch showed little deterioration of diode current over 6,000 hr., whereas the triode-connected batch failed in 500–1,000 hr. A typical example is shown in Fig. 1.

The phenomenon can be shown in effective fashion with a diode and triode assembled in the same envelope using opposite sides of a common cathode. Results from such a tube proportioned specially for

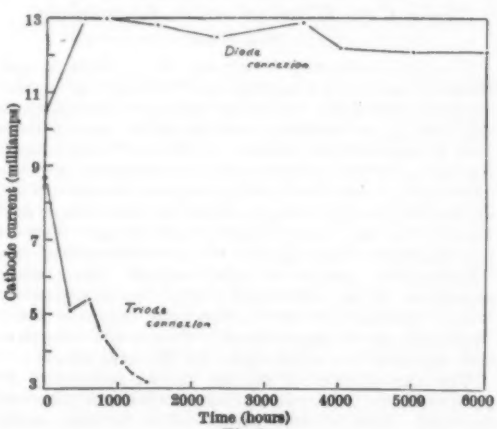

Fig. 1

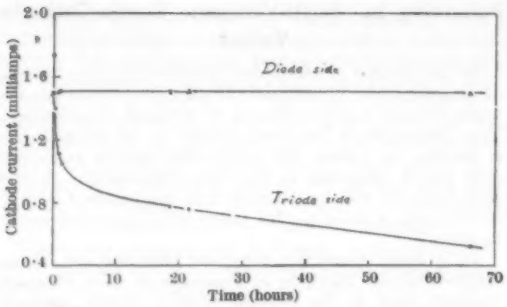

Fig. 2

the purpose are shown in Fig. 2. The anode voltage of the triode was 250 volts and of the diode 3 volts. In this case the currents recorded are temperature-limited with the cathode running at a temperature well below its nominal rating. The low temperature leaves the cathode in a state particularly sensitive to poisoning, and enables the experiment to be completed in a short space of time.

The essential difference between the diode and triode states is that in the former case the cathode is subject to residual gas atom bombardment, whereas in the latter case the cathode is subject to high-energy positive ion bombardment. The tentative conclusion reached is that the emission deterioration is due to positive ion bombardment and not directly to the traverse of current through the cathode. In a valve containing residual gas, the positive ion bombardment of the cathode is directly proportional to the cathode current, and the criterion of low cathode current density for long life remains. If means of removing the residual gas are achieved, then there appears reasonable hope for increasing cathode loading without prejudice to life.

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Twin Crystal Inclusions in Aluminium and Iron

The communication by Messrs. May, Tiedema and Burgers[1] reports the existence of minute unabsorbed crystals embedded in parent grains of aluminium and having a twinned orientation to the parent. Iron resembles aluminium in seldom showing annealing twins with typically straight boundaries. Twenty years ago[2], I reported upon some small ferrite crystals embedded in large recrystallized grains of iron, and found that they were twins of the parent. One of my suggested explanations of their occurrence was "unabsorbed grains of the original fine-grained aggregate whose orientations were by chance relatively twinned to that of the large crystals which eventually grew round them". This is the view now put forward for aluminium by Burgers *et al.*

The importance of correct initial grain size to produce large iron crystals has also been emphasized by Pfeil. Ferrite twins are found to be very stable and do not become absorbed after prolonged annealing below the A_3 temperature. At the time, attention was directed to the possible effect of these internal unabsorbed grains on the tensile properties of large crystals prepared by straining and annealing.

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[1] *Nature*, **163**, 740 (1948).
[2] *J. Iron and Steel Inst.*, **1**, 689 (1928).

Prof. O'Neill kindly sent us a copy of his comments. We regret that we were not aware of his paper. We should certainly have directed attention to the observations given therein, which, very probably, form another example of non-absorbed grains in twin-position with regard to the growing crystal.

In this connexion it would be worth while to investigate whether in iron, as in aluminium, the twin-relationship is only *approximately* fulfilled.

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W. G. Burgers

Thin Evaporated Calcium Fluoride Films

We have already outlined[1] the results of an X-ray examination of thin calcium fluoride films, evaporated on polished glass surfaces. The powder X-ray camera used was of the Seeman–Bohlin focusing type. It had a radius of 10 cm. and carried photographic film about 2 cm. wide set symmetrically to the mean plane of incidence of the X-rays. Consequently it was only the portions of the spectral lines due to the scattering in the immediate region of the incident plane which were recorded. From measurements of the relative intensities of the lines, it was evident that there was orientation of either the (111) or the (110) planes of the crystallites, and that this orientation depended on the temperature, T, of the glass substrate during deposition.

Recently, we have employed a cylindrical X-ray powder camera of the type described by Wyllie[2], and also a reflexion electron diffraction camera to examine films of calcium fluoride. As previously, these films were evaporated on to both polished crown and flint glass surfaces, and they had an optical thickness of $\frac{5}{4}\lambda$ 5500. From the positions of the intense arcs on the semi-circular lines appearing in the photographs of both cameras we have been led to the following conclusions. When the temperature is maintained at 25° C. during deposition the (111) planes are strongly orientated approximately parallel to the glass surface within a rocking angle of about 15° (that is, the angle between the glass surface and the (111) plane does not exceed about 15°). For a temperature of 110° C. there is no evidence of orientation of the (111) planes; but the (110) planes are strongly orientated approximately parallel to the surface, within a rocking angle of about 15°. This orientation of the (110) planes persists for temperatures up to 310° C., the highest temperature for which we have made measurements.

It is interesting to note that the orientation and the rocking angle of the crystallites in the films, as measured by the electron diffraction camera (35 kV. electrons), appear to be in good agreement with the

X-ray (iron $K\alpha$) results for the corresponding quantities. There is no indication, so far, that the magnitude of the rocking angle is influenced by the particular crystalline plane, the temperature or the composition of the glass surface.

J. Bannon
C. K. Coogan

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Aug. 9.

[1] Bannon, J., and Curnow, C. E., *Nature*, **161**, 136 (1948).
[2] Wyllie, M. R. T., *Rev. Sci. Instr.*, **18**, 425 (1947).

Determination of the Instants of Totality in Solar Eclipses

Banachiewicz proposed in 1928, and Bonsdorff and Lindblad carried out later, the precise determination of the instants of totality at distant places—in different continents—for calculating such distances. It is a sort of triangulation in which the distance moon–earth serves as a basis. Cinematography of the solar crescent and of a time signal with a teleobjective or with an objective-prism was used. The time of totality was calculated by extrapolation of the length of the solar crescent, by observing the cutting of the crescent by the moon's mountains and by photometry of the 'flash spectrum' lines.

The length of the crescent grows only with the square root of the time interval from totality, the moon's mountains move with the first power of the time, and their observation requires very good photographic images. The total intensity of the crescent grows in first approximation with the 3/2 power of the time: $i = i_e + a(t - t_0)^{3/2}$, where i_e is the intensity of the corona and a is the speed of the shadow of the moon upon the sun. Photometry of this total intensity, by chronographic photocell or by cinematography of the pupil of the telescope, is more precise than the methods indicated above and simpler than the photometry of particular flash-spectrum lines. The instruments must record the intensity of the corona and that of the crescent plus corona at a number of points—at least two. Relative photometric values are sufficient. If m_1, m_2 are the relative intensities of crescent plus corona in regard to that of the corona at two instants t_1, t_2, the time of totality contact is

$$t_0 = \frac{(m_1 - 1)^{2/3} t_2 - (m_2 - 1)^{2/3} t_1}{(m_1 - 1)^{2/3} - (m_2 - 1)^{2/3}}.$$

If the sensitivity of the instruments is high enough, it should be possible to work successfully even if the sky is clouded. As two out of three eclipses are occulted by clouds and as observation at two distant places is required, the probability of success should increase by a factor of nine.

Assuming a smooth edge of the lunar shadow, calculations show that the mean photometric error of one determination should easily be brought down to less than 0·01 sec.

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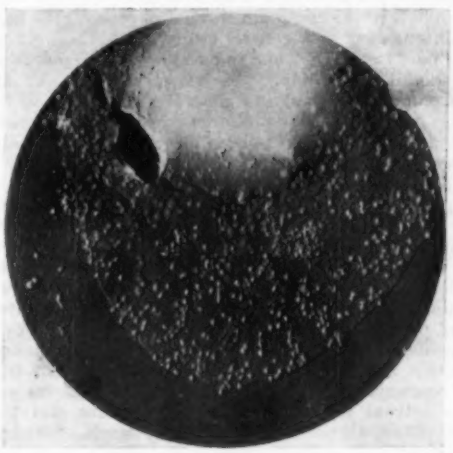
Electron Microscope Studies on the Interaction of Certain Viruses with Fowl Red Cell Membranes

The red cell agglutination test[1] has proved an invaluable means for the rapid assay of certain viruses, namely, influenza, Newcastle disease, fowl plague and mumps, and furthermore the red cell – virus system is serving as an experimental model for investigating some of the factors involved when a virus attacks a susceptible cell[2,3]. We have for some time been interested in the possibility of gaining direct optical evidence on the mechanism of the process. The membranes of the laked red cells can be successfully photographed in the electron microscope (Wolpers[4], Dawson and MacFarlane[5]), and this enables an optical study of the interaction of viruses with such membranes to be made.

Freshly washed fowl red cells are lysed by means of saponin[6] and again carefully washed. Such suspensions of cell 'ghosts' are mixed with the virus preparation under appropriate conditions for adsorption to take place, then washed and fixed with osmic acid, prior to mounting on the collodion film with the aid of an ordinary light microscope. The specimen is then shadowed with palladium ready for examination in the electron microscope.



Laked fowl red cell with *P.R.*8 strain of influenza virus adsorbed. Shadowed with palladium. Magnification, × 6,600

The most impressive photographs of adsorbed virus bodies have been obtained, and one showing adsorbed influenza virus accompanies this communication. Important points emerging from the early photographs were: (i) the general random distribution of virus bodies with no evident set pattern. As the surface is progressively packed with virus, then a close matt of virus covers the entire membrane surface. (ii) Counts of the numbers of particles per given area of membrane parallel the concentrations of virus determined on the fluids by other methods. A basis for roughly quantitative study of certain virus-cell relationships is thus provided. (iii) The adsorption is selective, and when the cell 'ghosts' are added to freshly harvested allantoic fluid, relatively clear pictures can at once be obtained. Space does not permit mention of the many interesting lines of study that this method opens up and which

we are actively pursuing. Successful photographs have already been taken of several strains of influenza virus, Newcastle disease virus, fowl plague virus and mumps virus, adsorbed on fowl cell membranes. A detailed account of our work will be presented elsewhere.

Just to hand is a paper by Heinmets[7] reporting successful photographs of influenza virus adsorbed on agglutinated and laked human red cells.

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Inorganic Chromatography on Cellulose

We have read with interest the letter of M. Lederer on the paper chromatography of the noble metals[1], especially as it appeared so soon after our own communication[2] on inorganic chromatography. We have been engaged in a general study of this subject for the past two years[3], and our results will be published in detail separately. In view, however, of Dr. Lederer's letter and the general interest which has been aroused by our preliminary communications[2,4], we give below some supplementary information which may be of value.

Separations involving the movement of solvent *up* a paper strip in a manner similar to that described by Lederer have been tried by us at various times, but, in general, we prefer the downward movement as providing quicker and rather more precise separations. The noble metals have also attracted our attention, and we have separated gold, platinum and palladium from each other and from iridium or rhodium. The solvent employed by us has been methyl *n*-propylketone containing 30 per cent (v/v) of concentrated hydrochloric acid. Gold moves with the solvent front, followed by platinum and then palladium, all three being in sharp bands. Rhodium and iridium move much more slowly and keep together under these conditions. As an interesting comparison with Lederer's work, the above solvent mixture only gives one liquid phase on the paper, although methyl *n*-propylketone containing between 5 and 25 per cent (v/v) of concentrated hydrochloric acid gives two phases. If ketone containing about 20 per cent acid is used in this separation, then the gold appears in the ketone phase while the palladium is found in the aqueous phase. The platinum is curiously split between the two phases, a sharp narrow band appearing in the aqueous part and a diffuse band in the ketone phase.

We have also separated the metals which are usually grouped together for analytical purposes as the copper and tin groups (II*a* and II*b*), using solutions of the chlorides. A good solvent for Group II*a* is ethyl *iso*propylketone containing 10 per cent concentrated hydrochloric acid (v/v). The order of the bands on the paper is: lead (least movement), copper, bismuth, cadmium and mercury. For the II*b* group (trivalent arsenic and antimony, divalent tin) the solvent used is dry ethyl acetate previously shaken with 2 per cent hydrochloric acid (v/v). In this case the original spot is not dried off and the atmosphere surrounding the paper strip is maintained at 100 per cent relative humidity. Arsenic moves but little, while antimony forms a sharp band below the arsenic; tin appears in a narrow band farther down the paper.

We have also extended the scale of the technique by employing columns of cellulose pulp, which have been used to study separations of inorganic salts both from an analytical and a preparative aspect. In many cases it has been found advantageous to activate the cellulose in order to increase its adsorptive properties, and this may be accomplished by boiling with dilute nitric acid for a short time. As examples of the analytical use of columns there may be mentioned the separation and estimation of nickel and cobalt in minerals and steels. The preparative use of the technique may be illustrated by the separation of scandium from a large number of metals, including those of the rare earths. With the salts as nitrates and using ether containing 12½ per cent (w/v) nitric acid as solvent, the scandium is readily washed through the column. Zirconium also tends to come through, but may be held back by adding tartaric acid to the original solution. Scandia obtained in this way is highly pure. Adsorbents other than cellulose are under study; but the latter has proved a generally convenient material.

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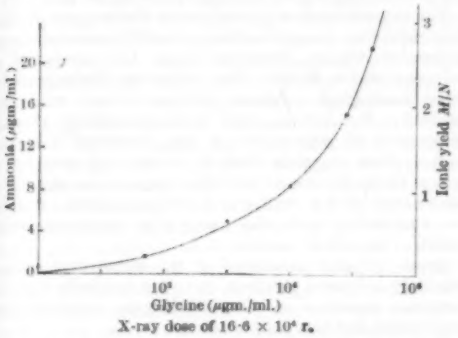
Relationship Between Structure of Nitrogenous Compounds and their Sensitivity to X-Rays

In previous investigations, the dependence of sensitivity to X-radiation on molecular structure has been examined for various compounds[1]. One of our more recent, unpublished, results is the deamination of amino-acids by X-radiation, which has been reported independently by Stein and Weiss[2]. On the basis of our experimental results, however, some difficulties exist concerning the mechanism of the reaction. Weiss[2] has put forward the hypothesis that the reaction of ionizing radiations is due to the formation of radicals formed by the splitting of water molecules. This simple mechanism should give an ionic yield of not more than unity if one OH radical is involved in the deamination of one mono-amino-mono-carboxylic acid molecule, and this appears to be the yield reported by these authors. We have, however, found that the ionic yield of the deamination of glycine rises gradually with its concentration to a value of three for 0·2 gm./ml. (see graph). This ionic yield exceeding unity means, when interpreted in terms of radicals,

that one OH radical can affect more than one amino-acid molecule, which is unlikely, or that one ion pair can give rise to more than one OH radical, or that some of the radiation energy can form radicals by excitation rather than by ionization. In general, therefore, one would always expect an ionic yield exceeding unity in relatively concentrated solutions, independent of the nature of the solute, with perhaps the exception of very big molecules. A further possibility, but remote in the case of deamination, would be a chain reaction of some sort.



The effect of the configuration of the molecule containing nitrogen or NH_2 groups is shown by our experimental results as follows. Urea is very radio-resistant judged by its low protective power when mixed with the enzyme carboxypeptidase, whereas thiourea proved to be highly protective[1], liberating sulphur on irradiation*, but neither of these compounds liberates ammonia. If, however, NH_2 is in the α-position of an amino-acid, ammonia is liberated, whereas the formation of ammonia from lysine-monohydrochloride is not increased when compared with glycine or alanine in equi-molar solution. Furthermore, glycine anhydride only gives traces of ammonia, and the peptide linkage in dipeptides (for example, leucyl–glycine) does not contribute to the ammonia yield. β-Alanine is less reactive than α-alanine. Histidine hydrochloride appears to be outstanding among the amino-acids examined, yielding a greater amount of ammonia in comparison with glycine, as if the glyoxaline part of the molecule is contributing to the effect. Glyoxaline on its own, however, yields too small an amount of ammonia to account for the increase of ammonia from histidine unless it becomes more reactive to an OH radical when joined to the alanine residue. The presence of the guanidine group in arginine does not raise the ammonia yield above that of glycine.

The X-ray dose applied in these experiments was of the order of 16×10^4 r.

These and related experimental results will be published elsewhere in detail.

*_Note added in proof._—The ionic yield of this reaction also rises to more than 3 on increasing the concentration to 8 per cent.

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Strengths of the Chloro-acetic Acids

It is well known that the introduction of chlorine atoms into acetic acid causes a rapid rise of dissociation constant (see accompanying table). If changes in the value of K are taken as a measure of the effect of the chlorine atoms, it would appear that the second chlorine atom has a *greater* effect than the first, and the third a *greater* effect than the second.

This particular phenomenon was discussed by Jenkins[1], who suggested that the progressive replacement of hydrogen by chlorine resulted in the stabilization of the ion by resonance among a rapidly increasing number of structures. We would like to suggest that this hypothesis is not really necessary, since we consider that the effect of structure upon ionization is truly measured, not by changes in K but by changes in $\ln K$, that is, by changes in the free energy of ionization ($-RT\ln K$). The justification for this is that changes in the free energy of ionization reflect directly changes in the energy and entropy factors, which are the fundamental quantities governing the equilibrium.

Further, we have shown, in a paper to be published elsewhere, the importance of additive relations in the free energy of ionization in interpreting the effect of structure on the dissociation of polysubstituted benzoic acids. In a similar manner, Stubbs and Hinshelwood[2] showed the significance of additive relations in the free energy of *activation* in explaining the effect of structure on reactivity for the benzoylation of disubstituted anilines.

The relevant free energy data for the chloro-acetic acids are given in the accompanying table (values of K_{25} taken from Watson, ref. 1).

Acid	$10^5 K_{25}$	Free energy of ionization ($-RT\ln K$) cal./mole	Change in the free energy of ionization for successive chlorine atoms. $\Delta(-RT\ln K)$ cal./mole
Acetic	1·82	+6450	—
Monochloro-acetic	155	+3830	−2620
Dichloro-acetic	5,140	+1760	−2070
Trichloro-acetic	121,000	− 110	−1870

It will be seen that, when the effect of each successive chlorine atom is measured by the change in free energy of ionization it produces, the second chlorine atom is *less* effective than the first, and the third *less* effective than the second. In other words, the influence of chlorine atoms on the ionization shows a saturation effect.

This effect can readily be explained. The carbon–chlorine dipoles within each molecule, being in close proximity to one another, will be subject to mutual induction effects; and each dipole will reduce to some extent the influence of the others on the ionization. Thus the effect of two chlorine atoms will be less than the sum of the effects of the atoms taken singly.

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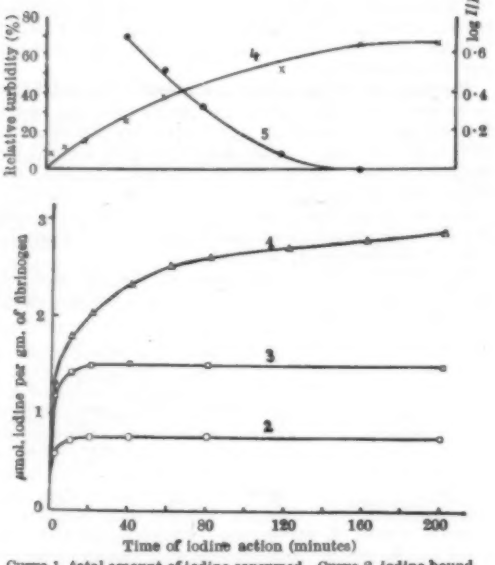
Action of Thrombin on Iodinated Fibrinogen

FIBRINOGEN dissolved in 30 per cent urea solution readily consumes iodine even at 0° C. Analysis has shown that the action of iodine is twofold: part of the consumed iodine is substituted in the tyrosine rings in the fibrinogen molecule, and part of the iodine oxidizes certain of its groups. Thus as a result of the action of iodine, fibrinogens, iodinated and oxidized to various extents, can be prepared. To obtain such iodinated fibrinogens, a known amount of $N/100$ iodine solution was allowed to act on samples of fibrinogen dissolved in slightly alkaline 30 per cent urea solution. After various incubation times the action of the iodine was stopped by removing the remaining free iodine with thiosulphate. The urea was then dialysed off and the fibrinogen precipitated isoelectrically several times and finally dissolved in slightly alkaline water. The iodine



Curve 1, total amount of iodine consumed. Curve 2, iodine bound to fibrinogen. Curve 3, calculated quantity of iodine used up for the substitution of tyrosine (taking two iodine atoms per tyrosine molecule, and two for the oxidation of two hydrogen atoms during substitution). Difference between curves 1 and 2 gives the quantity of iodine used for oxidation. Curve 4, optical density of the yellow fibrinogens. Curve 5, relative turbidity of iodinated fibrinogens due to the action of thrombin

bound to fibrinogen was then estimated. It was found that the iodine bound to the fibrinogen reached its maximum value in the first few minutes and then remained constant. This maximum value corresponds to two iodine atoms per tyrosine residue of fibrinogen. Simultaneously, the Millon reaction for phenolic groups disappeared.

The constant increase of consumption of iodine shows that the iodine not only enters the fibrinogen molecules but also oxidizes certain groups. As a result of this oxidation, yellow fibrinogen preparations were obtained, and the intensity of colour was found to increase proportionally with the iodine consumed.

Fibrinogens recovered from urea solution clot normally, but none of the fibrinogen exposed to the action of iodine forms a clot on the addition of thrombin. Thrombin, however, still has a certain effect on these fibrinogens, since after its addition there is a shift in the isoelectric point of the fibrinogen towards the alkaline side. There is also a decrease in the solubility of the fibrinogen molecules, which causes turbidity in the otherwise clear solutions. The turbidity was found to decrease as the yellow colour increased. The results are summed up in the accompanying graph.

In some earlier experiments[1], it was found that the formation of the fibrin takes place in two stages; and the role of the thrombin is to modify the fibrinogen molecules, which then polymerize to fibrin.

The experiments with iodinated fibrinogens showed that thrombin was still able to modify these iodinated molecules which, however, lost the property of polymerizing to fibrin. The iodinated fibrinogens become insensitive towards thrombin only when the oxidation by iodine, and correspondingly the development of yellow colour, has exceeded a certain value. This suggests that thrombin requires for its action those groups of the fibrinogen molecules which are oxidizable by iodine to a yellow colour, or which are oxidizable with the same ease as those which give rise to yellow colour.

Since tyrosine iodinated in the same way gives a similarly coloured product, it is not unlikely that the tyrosine residues in the fibrinogen molecule are responsible for the yellow colour.

Yellow iodinated fibrinogens on which thrombin has no action still form mixed clots with untreated fibrinogen, provided that the yellow fibrinogen is not added in excess over normal fibrinogen. The excess of the yellow iodinated fibrinogen inhibits the clot formation of fibrinogen.

A detailed account of this work will appear elsewhere.

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Nucleic Acids in *Drosophila* Eggs, and *Y*-Chromosome Effects

CALLAN'S recent extension[1] of our study of the effect of the *Y*-chromosome on the egg cytoplasm of *Drosophila*[1,2] has given results apparently at variance with those we obtained. A brief comment at the present time may be of some use, in clarifying the issues involved for further work.

The data presented by Callan pose two problems. One is the difference of technique: we used the ultra-violet absorption; he used a test for the carbohydrate component of the nucleic acids. Both methods have their weaknesses; but it is fair to say that the results to date have been in good agreement when tests have been made on the same tissues. As Callan points out—and this brings us to the second point—it is not easy to make a direct comparison of the two methods for the stages of oogenesis used in the ultra-violet study. He therefore used eggs laid over a one-hour period, hoping in this way to obtain large enough numbers of eggs at a uniform stage for analysis by the method he used. Unfortunately, however, in *Drosophila* the first twelve cleavage

divisions are completed[4] in 120 min. after fertilization at 25° C. It follows, therefore, that Callan's population of eggs must have been fairly heterogeneous, with a variety of early developmental stages included, in which the nucleic acid changes occurring cannot as yet be specified. Since also there has been no comparison of early development in the two types of eggs, it is difficult to say whether or not a difference in nucleic acid content at these stages is to be expected between the eggs from *XX* and *XXY* mothers. This is an intrinsic difficulty with the technique used in Callan's study, one which, it is proper to say, has deterred us from attempts in that direction: the interpretation of the data, no matter how precise the determination, must be ambiguous with large populations of eggs of mixed developmental stages.

One additional point regarding the comparison of mature eggs and growing oocytes. The mature egg contains in its cytoplasm not only the cytoplasm of the *Drosophila* oocyte, but also incorporates the fifteen nurse cells as well. We have not compared the ultra-violet absorption of *XX* and *XXY* nurse cells; their high absorption necessitates special procedures, not available at the time. It could well be that the effect of the *Y* in the female is most evident in the oocyte proper, in the same way that in the male the most striking effect of the *Y* is on the later stages of spermatogenesis[5]. In such an event, the effect on the total cytoplasm of the egg could well be obscured in measurements like those reported by Callan. All these points serve to indicate the need for further analysis of the problem, both in the egg and in tissues where comparisons of diverse techniques are more easily made. Such studies are under way in our laboratories.

Finally, a point of theory. The argument connecting heterochromatin with the control of nucleic acid synthesis (changes in nucleic acid content connected with changes in heterochromatin) does not necessarily demand that changes in heterochromatin will result in changes in protein synthesis. Such changes may occur, and it is a prime necessity to find experimental material in which the possible correlation may be studied critically. But failure to observe effects of added heterochromatin on growth-rate or oxygen consumption has relevance at present only to the difficulty of the problem. This is particularly true in *Drosophila*, where the heterochromatic regions have been defined as genetically inert, in the sense that duplication or deficiency produce no evident effect on the morphology or growth of the fly[6]. The nucleic acids may be a necessary concomitant of protein synthesis, but they are certainly not sufficient in themselves: the limitations imposed by other factors may disguise any effects exerted by variations in the nucleic acid content.

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A Complete Life-Cycle in the 'Germ-Free' Bantam Chicken

AFTER Pasteur raised his classical question in 1885 about germ-free life[1], several investigators attempted to rear chickens under germ-free conditions[2–4]. The longest of these experiments, conducted in these laboratories, lasted about five months[4]. We now report the completion of the life-cycle in 'germ-free' chickens, that is, the successful rearing of chickens to maturity, the production and incubation of fertile eggs and finally the hatching of a young chicken, all in germ-free conditions. This is the second germ-free vertebrate which we have been able to carry through a complete life-cycle; the first being the albino rat[7]. (The term 'germ-free' is used because of historical precedence. It should be taken to mean that the animals are free from demonstrable living micro-organisms. In itself the term is confusing because it is obvious that a fertile egg is not germ-free. The question of proper terminology is taken up in some detail in LOBUND Reports No. 2, which is now in the press.)

While a detailed description of our methods is in the press[8], the essential steps of these methods can be summarized as follows: White Wyandotte Bantam eggs containing viable 20-day embryos were dipped in mercuric chloride (1–100) at 38° C. for 8 min. after being scrubbed thoroughly in a detergent solution (38° C.). They were then passed through a germicidal trap into the Reyniers' germ-free system, where hatching was completed. After hatching, the eggshells were removed, and food, water and culture tubes were taken into the germ-free rearing unit through a sterile lock after being subjected to 123° C. saturated steam for 20 min. Negative pressure of 28 in. mercury was held in the lock for 10 min. before and after sterilization.

The semisynthetic diet (*L*-137) used is given in gm. per kgm. unless otherwise noted: casein, 250; gelatin, 100; L-cystine, 2; corn oil, 60; corn starch, 450; lactose, 40; whole liver powder (pork), 20; yeast extract, 20; vitamin A esters, 4,000 I.U.; ascorbic acid, 2; vitamin D_3, 500 A.O.A.C. units; tocopherol, 0·25; 2-methyl-1, 4-naphthaquinone, 0·05; thiamin Cl.HCl, 0·06; riboflavin, 0·03; calcium pantothenate, 0·2; nicotinamide, 0·05; choline Cl, 2·0; pyridoxine Cl, 0·02; i-inositol, 1·0; biotin, 0·0004; folic acid, 0·01; $CaCO_3$, 15·0; $CaHPO_4$, 2·75; K_2HPO_4, 11·3; Na_2HPO_4, 10·0; NaCl, 2·5; KI, 0·0375; $MgSO_4.7H_2O$, 3·75; $MnSO_4.4H_2O$, 0·68; $FeC_6H_5O_7$, 3·75; $CuSO_4.5H_2O$, 0·19; $CaCl_2.6H_2O$, 0·025; $ZnSO_4.7H_2O$, 0·05; $Na_2B_4O_7.10H_2O$, 0·025; $AlK(SO_4)_2.12H_2O$, 0·0375.

The chickens, the interior of the germ-free unit, food, water, utensils and glove surfaces were checked for contamination within 48 hours after hatching, and bi-weekly thereafter. Both microscopic and culturing techniques were used, and some of the animals were further examined at death or sacrifice. The details of the microbiological procedures are reported elsewhere[8].

In the experiment reported, 17 eggs were passed into the germ-free system and 12 hatched. One chick died after hatching, and eight were sacrificed for examination. The remaining three, two cocks and one hen, were reared to maturity and are 231 days old at the time of writing. Growth and general appearance are satisfactory. The hen started to lay when 190 days old. Microbiological tests of the animals are negative.

Three of the first eggs laid by the germ-free hen were incubated in the germ-free system. Two were cracked, but an embryo developed for 15 days in one of them. The uncracked egg hatched. This chick has been maintained on a similar diet (*L*-165—contains 1 per cent more salts) to the parent animals.

Microbiological tests on the animal have been negative to date.

In our opinion the chief importance of this work is to provide standard experimental animals with fewer variables for investigations in experimental biology and medicine. At this time it seems that the use of germ-free animals is most promising in the fields of immunology and nutrition.

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Inadequacy of Potometry for Measuring Plant Transpiration

IN plant physiology potometry is still frequently considered a suitable method for measuring plant transpiration provided that the plant organs are cut under certain precautions, namely, under very clean distilled water, previously boiled, in order that the formation of gas bubbles in the vessels be avoided. Of course, the transfer of the cut stems or leaf-stalks to the potometer must be done without bringing the cut surface into contact with the air.

Nevertheless, potometry can give quite misleading results. This was shown in 1921 by Loftfield[1] for several plants; but he did not give any explanation of what happens with the plants when cut and brought to the potometer. To elucidate this, we carried out three series of experiments, which can easily be repeated.

(1) We cut leaf-stalks of nasturtium (*Tropæolum majus*), taking the precautions mentioned above, at midday in sunny weather. The stomata of the leaves were, of course, open. These cut leaves were exposed in small Erlenmeyer flasks to the same conditions of insolation and transpiration as the intact plants in the garden. Within 5–10 minutes—under São Paulo summer conditions—the cut leaves began to wilt. We repeated the experiment, transferring this time the cut leaves to potometers, and we noted a rapid and intense decline of the water absorption, also accompanied by wilting of the leaves. A great number of other species showed the same behaviour.

(2) With a dissecting microscope we observed that the xylem vessels of the stems and leaf-stalks that had been treated as described above were full of gas, in a continuous column or in the form of bubbles. For this observation the stems or stalks must be cut open under water or under liquid paraffin; without being taken out of the liquid, they were observed under the microscope in Petri dishes. If an appropriate illumination is used, the gas in the vessels is easily detected.

It is equally easy to show that in intact small plants the vessels are full of water, without bubbles, as was already demonstrated by Bode[2], for example, in *Impatiens*. To verify this we prepared a 'window' by removing a part of the epidermis and of the outer layer of the parenchyma. So long as the vessels are filled with water, they do not appear very distinctly; but when containing gas they stand out brilliantly. We submitted such a plant to slow drying (removing the water from the Petri dish), and then we observed that the water cohesion in the vessels remained intact for a certain time. When the same plant was submerged in clean water (or in liquid paraffin), and the stem cut above or beneath the window with a sharp razor blade, gas bubbles formed instantaneously in some or in all of the xylem vessels. The same took place if we did not cut the vessels but instead simply applied pressure to them or merely to the adjacent parenchyma, for example, by a dissecting needle. This latter observation has already been mentioned, in another connexion, by Bode[3]. It is surprising to see how rapidly the gas appears in the vessels, not only in those near the surface of the window, but even in deeper parts of the stem. This happens only when the vessels are in a state of negative pressure, in under-saturated plants. The same rupture of cohesion has been produced in artificial models by Dixon[3], when water under negative pressure was subjected to mechanical shock. It is likely to occur in the vessels whenever under-saturated plants are cut under water.

(3) Rupture of water cohesion can be brought about in the annulus cells of leptosporangiate ferns, the classic model for water cohesion studies. We exposed ripe sporangia of *Polystichum adiantiforme* Forst to a solution of 35 per cent glycerin. In this concentration the rupture of nearly all sporangia took place; but the cohesion of the sap of the annulus cells still remained intact. (Its rupture required concentrations of more than 40 per cent.)

If a slight pressure on the coverslip was applied, nearly all the annuli recoiled and gas bubbles instantly appeared in most annulus cells. (The annulus of *Polystichum adiantiforme* is not quite impermeable to glycerin; therefore, the experiment must be carried out within a few hours. When the sporangia remained twelve hours in the 35 per cent solution, they no longer reacted; and instead of a 40 per cent solution a much stronger one must be applied to break the cohesion.)

These are the essential facts which occur when plants are cut under conditions of under-saturation. Another factor that handicaps water conduction in cut stems is the excretion of slimy liquids from the cut surface. This excretion may derive from the sieve tubes; but in *Tropæolum* it can be seen coming out in considerable quantity from the parenchyma. (It is evident that such excretions upset the above-mentioned precautions, namely, using distilled and especially cleaned water.) These colloidal substances can be seen entering the xylem vessels and accumulating at the transversal septa. Therefore, if leaves of *Tropæolum* are cut under saturated conditions, their conduction diminishes first by obstruction of the

septa as a consequence of slime accumulation, and later by cohesion rupture.

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Glomus Cells in the Human Choroid

I HAVE seen hitherto unnoted large round or polyhedric cells, of 10–20 μ diameter, in the outskirts of middle-sized and big choroidal arteries in the region of the posterior pole of many human eyes. These big cells are conspicuous by their clear cytoplasm, only a few of them containing small granules. The plasm is outlined by a smooth continuous cell membrane. The nuclei are stained with hæmatoxylin an even dark purple without visible chromosomes or nucleoli; they are round or oblong and situated predominantly centrally. These large cells are present relatively infrequently in normal choroid (Fig. 1), where they are found singly; they occur in groups in the media or adventitia of arteries in cases of hypertension and other circulatory disturbances (Fig. 2).

These cells correspond to von Schuhmacher's glomus cells[1], the so-called 'epitheloid muscle cells'. Glomus cells have been identified with the 'cushion cells' filling the lumen of arterio-venous anastomoses of certain tissues[2] and are supposed to be of great biological importance[3], as they are connected with the short-circuit from artery to vein, essential in many physiological and pathological processes.

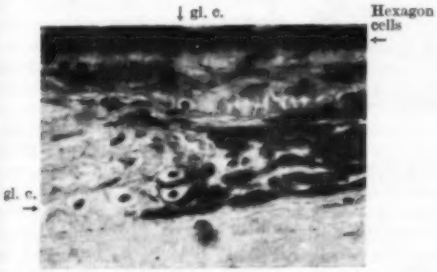

Fig. 1. Glomus cells in the choroid of a supposed normal eye. × 150

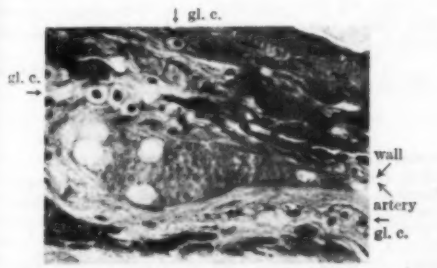

Fig. 2. Glomus cells in an arterial wall in the choroid of a hypertensive arteriosclerotic patient. × 150

In none of the routine sections have I seen a lumen within the glomus groups, but their relation to the vessel wall is obvious. These cells may be the 'swell cells' in the arterio-venous short-circuits, and may open these channels by shrinking, and close them by swelling, as is assumed by the majority of investigators. We cannot exclude, on the other hand, that they are contracting elements, constricting certain vessels from the outside. It is probable that both types occur side by side. In any event, although they have not been examined histologically hitherto, they are certainly present, and belong to the elaborate regulating system of choroidal blood circulation which adapts this corpus cavernosum of the eye[4] admirably to the frequent changes of intra-ocular pressure.

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Spore Prints from Individual Phialides of *Verticillium* spp.

STERILE soil-extract agar *p*H 4 (without mineral or organic additions) is allowed to set in a Petri dish. Using a fine rod finished off at the tip into a small glass bead, the agar surface is streaked with the given spore suspension or smear, care being taken to avoid breaking the surface. When phialospores are being produced in appreciable numbers, rectangular pieces of coverslip are placed flat on the surface of the agar close to and on opposite sides of the streak, and entire coverslips are then rested on them so as to cover the streak. Using a 1/5 obj. and ocular × 10 the upper surface of the coverslip is first brought into focus. Downward racking with the fine adjustment is then continued until phialides and spores are observed at or near the underside of the coverslip. Many upwardly directed phialides will have been caused to deposit their spores against the coverslip by this means, and in many cases the points of the phialides may be observed beside their own spore or spores. Phialides at a lower focus can also be caused to deposit their spores if the lens is pressed gradually down on the coverslip by means of the fine adjustment. In fact, it is quite possible, first to observe individual phialides bearing a spore mass, and then to pick off these spores by pressing the coverslip against them. The spore or spore masses may then be observed at a higher focus lying on the coverslip, and by again focusing downwards their previous relation to the now sporeless phialide-tips may be checked.

This method has enabled me to establish clearly: (*a*) multiple-spore production by individual phialides of *Verticillium psalliotæ*; (*b*) variation in size and shape of spores produced from the same phialide, namely, one or a few large crescent-shaped spores and a variable number of smaller crescent-shaped or oval spores. Many of the apparently oval spores are actually crescent-shaped but appear oval when viewed from the convex or opposite aspect (that is, concave or plane). Those which are truly oval are

immature and their relative frequency would naturally depend on the age of the culture. Treschow[1], in his original description of *V. psalliotæ*, recorded that the phialides of this species produced only one spore, and that this was usually convexo-concave or convexo-plane, although a few were oval.

The use of coverslips in the manner described serves also for the observation of spore production in *V. Malthousei* Ware, as well as of spore rotation in both species, which I recorded[2] in a previous communication. As it might also be of interest to some workers to know the relative abundance under different conditions of spore production from individual phialides of various disease-producing species of *Verticillium* and other genera such as *Fusarium*, the use of this technique might perhaps provide interesting statistical data.

I acknowledge with thanks the permission of the director of research and of the directors of the Mushroom Research Association to publish this information.

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Regeneration of the Hypophysial Portal Vessels

There would seem little doubt that the nervous system controls the activity of the anterior pituitary gland, but the mechanism by which this control is exerted is debatable. Many workers have cut possible nerve pathways to the gland. Interruption or removal of the cervical sympathetic system, or the facial and petrosal nerves, has little or no effect on the normal functioning of the gland. Section of the pituitary stalk has given discordant results in the hands of different workers[1], but it would seem established that some animals retain normal anterior pituitary function after this operation. This fact indicates that the nerve fibres of the pituitary stalk are not involved in the link between the nervous system and the anterior pituitary, for once cut these fibres do not regenerate.

However, little attention has been paid to the possibility that the hypothalamus may control the anterior pituitary gland by liberating a humoral excitant into the hypophysial portal vessels, which then transmit the substance along the pituitary stalk to the gland[2,3]. If this is so, variable results might be expected to follow pituitary stalk section, for, as suggested[3], regeneration of these vessels might occur. This possibility has been tested in the following manner.

The pituitary stalk has been sectioned in twenty-nine female rats. The operative approach was by a temporal route which gives a clear view of the stalk and surrounding structures, and allows a deliberate and precise lesion to be made in any desired site. The œstrous cycles of these animals were followed by the vaginal smear technique, and they were tested for a pseudo-pregnancy response to sterile coitus by the deciduoma reaction. Many of the animals showed a normal sexual rhythm and pseudo-pregnancy response after recovery from the operation, and these results are being reported in detail elsewhere. After observation (usually for three months) the animals were killed and the vascular systems perfused with indian ink solution. The heads were decalcified and a block of tissue containing the hypothalamus and pituitary gland serially sectioned in celloidin at 100–200 μ. On histological examination it was seen that the neural lobe was atrophic, the pars intermedia enlarged relative to the rest of the gland, and, in many cases, the pars distalis appeared slightly diminished in size. The point that has been clearly established is that in many cases the hypophysial portal vessels showed regeneration across the cut region of the stalk (Figs. 1 and 2).

The hypothesis of neurovascular transmission of stimuli from the median eminence of the tuber cinereum to the anterior pituitary finds indirect support from two sources. First, the anatomical evidence that the hypophysial portal vessels are present in a wide variety of vertebrates though nerve fibres in the anterior pituitary gland are scarce[2,4,5], and microscopic observation of these vessels in the living rat has shown the blood flow to be from the tuber cinereum to the anterior pituitary[6]. Secondly, the experimental evidence that (*a*) electrical stimulation of the tuber cinereum in rabbits (for three minutes) may produce ovulation, whereas similar stimuli applied to the anterior pituitary directly (for seven and a half hours) does not produce this result, indicating a lack of secretomotor nerve fibres in this gland and probably a humoral transmission of stimuli[7], and similar evidence[8]; and (*b*) section of the pituitary stalk results in variable degrees of dysfunction of the anterior pituitary, which it would seem likely may be correlated with varying degrees of regeneration of the portal vessels.

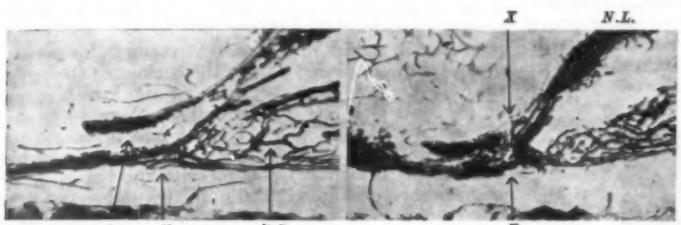

Fig. 1

Fig. 2

Fig. 1. Photomicrograph of a mid-sagittal section through the pituitary stalk of a control rat. Vascular system perfused with indian ink. Note the portal vessels (*V*) passing from the ventral surface of the pituitary stalk (*S*) into the pars distalis (*P.D.*). Magnification × *c.* 50

Fig. 2. Photomicrograph of a mid-sagittal section through the pituitary stalk of a rat in which the stalk had been sectioned ten weeks previously. Vascular system perfused with indian ink. The neural lobe (*N.L.*) of this gland showed marked atrophy. Note the large regenerated portal trunk passing across the ventral surface of the line of section (*XX*) from the tuber cinereum (on the left) to the pars distalis (on the right). Magnification × *c.* 50

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USE OF RADIOACTIVE PHOSPHORUS IN PLANT NUTRITIONAL STUDIES

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THE majority of investigators who have used radioactive isotopes in experiments with plants have satisfied themselves that the likelihood of radiation damage is negligible at the concentrations necessary for tracer investigations[1,2,3]. It appears, however, that little detailed research on this question has been undertaken. Since even a small degree of radiation damage could vitiate the results of a plant physiological study, it seemed to us essential that as a preliminary to a programme of tracer investigations we should attempt to define the limits of possible damage. The work is still at an early stage; but, as some of the results have a direct bearing on the general design and planning of tracer experiments, it appears desirable to publish a preliminary report.

We have treated young barley plants, of which the second leaf on the main axis is fully expanded, with levels of phosphorus-32 in the form of phosphate varying from 0·5 to 50 microcuries (μC.) per litre of culture solution over periods of four to six days. The range of concentration was selected in the light of Arnon's[1] finding that 30 μC. phosphorus-32 per litre was a satisfactory level of tracer in experiments lasting for similar periods. The amount of total phosphate has been varied within a wide range. To ensure rapid absorption of phosphorus the plants were grown, prior to the experimental period, in a solution lacking phosphorus but otherwise containing a balanced and ample supply of nutrients. The cultures have been well aerated and the *p*H adjusted to 6·0.

The phosphorus-32 was prepared at the Atomic Energy Research Establishment by the neutron bombardment of sulphur, and spectrographic analyses show no significant level of impurities. Radioactivity has been determined in solution using the tube described by Veall[4]. We have found this a more convenient and accurate procedure than the assaying of small samples of dry ash. Total phosphorus determinations, made by the method of Allen[5], indicate no significant difference in the rate of movement of tracer and carrier in the plants. There is, therefore, justification for assuming that the bulk of the phosphorus-32 in this preparation was present in the form of phosphate ions. Since, however, the form of phosphorus-32 has in other investigations caused difficulties, the question is being further investigated.

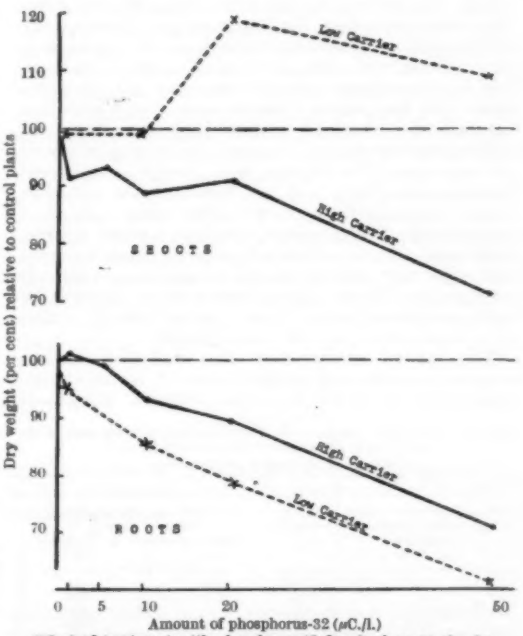
The effects on the dry matter production of roots and shoots after treatment for six days with phosphorus-32 at various dosages are shown in the accompanying graph. For convenience the results are expressed as the percentage of the values for control plants which were given the same levels of total phosphate, but no phosphorus-32. Two levels of total phosphate were employed: 'high carrier', 1 milli-equivalent-H_3PO_4 per litre, and 'low carrier', less than 10^{-3} milli-equivalents.

The reduction in the weight of roots relative to the control is highly significant ($P = 0·01$ or less) at both levels of total phosphorus. This effect is considerably greater at the low level, in which significant reduction occurs when the dosage reaches 10 μC.

Visual symptoms have also been observed, though the degree to which they develop is variable and their incidence follows rather than precedes the weight changes. There may be swelling of root tips followed by death, together with the formation of numerous thin laterals.

A significant reduction ($P = 0·04$) in the weight of shoots occurred at the high total phosphorus-level. At the low level there is no significant effect; but the tendency of the shoots to become heavier in the higher radiation treatments suggests that more precise investigations may show that extreme radiation damage of roots may, under certain conditions, result in a temporary increase in shoot weight, presumably a consequence of reduced downward translocation. Marked changes occur also in the phosphorus content of roots in the high-carrier treatment, the content for the 50 μC. treatment being 40 per cent of the 5 μC. value. There are, however, no comparable changes in the shoots. Thus, nutrient absorption appears to be affected by radiation to a greater extent than dry matter production. Other experiments indicate that there is some depression of phosphorus absorption at levels of phosphorus-32 below 15 μC., but the effects fall short of statistical significance. It is to be emphasized that it has been necessary to carry out these preliminary experiments on a comparatively small scale. Experimental errors have, therefore, been considerable; more precise studies may well show biological effects at even lower levels.

The accumulation of phosphorus in the apical meristems of the roots provides some explanation of



Effect of treatment with phosphorus-32 for six days on the dry weights of shoots and roots of young barley plants supplied with two levels of phosphorus-31 as carrier. The control plants received no phosphorus-32

Table 1. Ratio of phosphorus-32 concentration in apical segments of barley roots to that of the initial culture solution

Phosphorus-32 content of culture solution (initial)	Level of total phosphorus in culture solution (milli-equivalents-H_3PO_4/litre)				
	2	1	10^{-2} or less		
μC./litre	*b*	*a*	*a*	*b*	*c*
1·5	32			1420	1270
5	28	50	1370	1180	1100
10		50	1430		1680
15	20			980	
20		70	730		
50		18	300		
Mean	27	50		1130	

a duration of experiment 6 days
b „ „ „ 4 „
c „ „ „ 1 day

the observed effects. We have determined the radioactivity of the apical 0·5 cm. of roots and compared this with the initial activity of the culture solutions in three experiments (Table 1). At high levels of total phosphorus (1 or 2 milli-equivalents-H_3PO_4 per litre) accumulations of 20–70 times the initial external concentration are shown, while at low levels of total phosphorus (10^{-2} milli-equivalents or less) the average accumulation exceeded 1,100. This high level is reached within twenty-four hours of treatment, and there is some indication that accumulation is reduced in consequence of radiation damage. Calculations have been made of the radiation dose-rate in rontgens equivalent physical (reps.) per day for the initial culture solutions and the root tips[6] (Table 2). Allowance has been made for the dimensions of the root tips being less than the range of β-particles[7]. For the purpose of this correction the root tips, the average volume of which was 0·7 mm.³, have been treated as spheres. Since it is known from radio-autographs that phosphorus-32 was not evenly distributed in the meristems, the maximum dose-rates will exceed the figures shown. The approximate nature of these calculations must be emphasized, but they indicate that, although the radiation dose-rate in the culture solutions was very low, the root tips of the low carrier treatments in which radiation damage was observed received 300 reps./day. In high-carrier treatments damage has been established at dose-rates of 20–29 reps./day. Parallel cytological investigations have not yet been carried out, but there is evidence from the literature that equivalent total dosages from external radiation sources significantly affect nuclear division[8]; though, since different dose-rates were employed, the results are not strictly comparable. There is also some evidence that similar total radiation levels from phosphorus-32 affect cytoplasmic viscosity and absorption[9].

The present results show that radiation damage may be a much more serious hazard in tracer experiments than the literature led us to expect. Significant radiation effects have been observed when the level of phosphorus-32 is 10 μC./litre. Since radiation damage under these conditions is occasioned by the accumulation of phosphorus-32 within the plant, the level of tracer at which injury occurs will vary between experiments according to the rate of nutrient accumulation of the plants, the level of carrier, and the duration of the experiment. Rapidly growing young plants, such as those we have worked with, should be more easily damaged than older and less active material. This may, perhaps, be the explanation for the difference between Arnon's[1] and our own findings, since his experiments were carried out on tomato plants at an advanced stage of growth. Similarly, much higher levels of phosphorus-32 may be expected to cause no biological effects in experiments lasting a short time, for example, those of Overstreet and Jacobsen[10].

Table 2. Radiation dosage in the initial culture solution and in the root tips in the experiments shown in Table 1

Rontgens equivalent physical/day

Phosphorus-32 content of culture solution (initial) μC./litre	Culture solution	Root tips: Level of total phosphorus in culture solution (milli-equivalents-H_3PO_4/litre)		
		2	1	10^{-2}
1·5	0·06	1·0		40
5	0·2	2·8	5	120
10	0·4		10	300
15	0·6	6·0		300
20	0·8		30	300
50	2·0		20	300

Although these findings do not indicate any obstacles to the use of tracers in plant studies which cannot be overcome by careful techniques, the conclusion is inescapable that in general the hazard of radiation damage has not been sufficiently realized. The absence of any change in the weight of the above-ground parts of plants does not constitute a valid proof that radiation damage has not occurred, an assumption made by Hendricks and his co-workers in their extensive investigations[8]. The value of the results of any tracer investigation is doubtful unless the absence of radiation damage is established—and at the present time this can be done only by the careful analysis of plants treated with varying levels of radioactivity under the conditions of the experiment. Further work should, however, permit less laborious methods to be employed.

We are indebted to the Agricultural Research Council for a grant-in-aid of these investigations, and we wish to thank Prof. G. E. Blackman for much stimulating encouragement. We are also grateful to Dr. L. H. Gray and members of his staff at the Medical Research Council Radiotherapeutic Unit, and to the Atomic Energy Research Establishment, Harwell, for much valuable advice.

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ROTARY WING AIRCRAFT

INTEREST in Great Britain in rotating wing development has been particularly marked in recent months, not only as a result of the establishment of a new helicopter speed record by a British machine, but also because for the first time there are several British helicopters being designed, built and flown. It was, therefore, in a mood of optimism that a large audience, including several well-known French exponents, gathered at the Institution of Civil Engineers on November 20 to hear a series of lectures on helicopter problems with particular emphasis on civil use, given by some of the leading British technical workers and designers in this field. The meeting was a joint one

of the Royal Aeronautical Society and the Helicopter Association of Great Britain, all the papers being provided by members of the latter body.

The first paper was read by Wing Commander R. A. C. Brie, the well-known auto-gyro and helicopter pilot, on "The Operational Point of View". He presented the results of two years on operations using Sikorsky helicopters in Great Britain; classifying the problems into three broad groups, engineering, flying and operational characteristics, he covered the wide field of the actual use of the helicopter. He pointed out that many of the factors tending to reduce the utilization of fixed wing aircraft are more than ever applicable to helicopters, both because of the mechanical complexity and the need for compactness, and advocated the use of easily removable units and improved accessibility. The need for special tools and extractors required to permit easy breakdown and assembly was also emphasized.

Referring to the problems of flying, Wing Commander Brie emphasized the difficulties associated with night- and blind-flying, and the necessity for achieving slow rates of descent in autorotation. He stressed the importance of safety both for ground use and flying personnel. Pointing out that at present helicopters cannot be used economically except for special purposes, he gave his views on the need for comfort for passenger machines and the necessity for low vibrational- and sound-levels. He particularly stressed that the twin-engine types would eventually appear as the standard machine, particularly for operation over populated routes.

The second speaker was Capt. R. N. Liptrot, who discussed the technical problems of the civil helicopter. He dealt with the conventional problems of vibration and stability, and pointed out that although the use of flapping hinges relieves the periodic bending moments due to the varying lift forces, and drag hinges relieve the Coriolis moments induced during flapping, there are left hunting oscillations due to the fact that one of the natural frequencies of oscillation about the drag hinge is of the same order as the rotor rate of rotation. He also referred to the effect of tip stalling in producing additional vibration, and expressed the view that vibration rather than the compressibility effect may eventually be the major factor in limiting the forward speed of helicopters. He spoke at length about the problem of stability, remarking that the characteristics of most single rotor machines are still inadequate, and stressing the need for improvement. It is a pity that time did not permit him to refer to the work being done in Great Britain by Dr. G. J. Sissingh and his associates on automatic stabilization (which formed the subject of a lecture and discussion at a recent meeting of the Helicopter Association).

Capt. Liptrot referred to the difficulty of flying resulting from the use of an additional control, namely, the collective pitch control, and advocated the simplification of controls. This point is of particular interest in view of some of the claims made later for the Fairey gyrodyne. He pointed out that there is a danger zone between an altitude of 300 ft., above which autorotative descent is possible, and 50 ft. altitude, below which an increase of collective pitch facilitates safe landing. The reduction of this zone is of major importance and no doubt great effort will be expended in the future in this direction.

On maintenance questions, Capt. Liptrot referred to the troubles arising as a result of friction oxidation or 'false Brinnelling' occurring in oscillating bearings, such as those used for flapping- and drag-hinges, where the angular range used is limited. The engine installation of some of the early types of helicopters was far from satisfactory. It is important at the present time that parts be designed for longer life, longer periods between inspection and greater simplicity everywhere.

During the afternoon, three eminent designers of helicopters expressed the point of view of the constructor's reaction to helicopter problems.

The first, Dr. J. A. J. Bennett, whose long association with rotary-wing aircraft is particularly noteworthy, gave some details of the Fairey gyrodyne. This machine is undoubtedly one of the most advanced technically of any of the helicopters flying to-day. It incorporates all the usual vibration palliatives such as δ3 hinges, flexible blades of low solidity, high torsional blade stiffness, hydraulic dampers imposing little constraint and, typical of this type of lay-out, a tip-path plane maintained parallel to the direction of motion in forward flight, thus avoiding the periodic tip stall. What vibration is left is eliminated from the controls by the use of a hydraulic irreversible system, without doubt a step forward in control design.

Probably the most interesting engineering feature of the design is the elimination of the fourth control by means of an automatic pitch-change unit, the lag angle in azimuth associated with a varying torque resulting in a variation in blade-angle setting. Stability is achieved in forward flight by the use of a tail plane, and since the aircraft is specifically designed for fast forward motion, the resulting characteristics are very satisfactory.

Dr. Bennett did not say whether he had considered the possibilities of using flaps on the short stub fairings, and it would have been interesting to have heard his views on this point.

The second speaker of the afternoon was Mr. Raoul Hafner, whose reputation in this field is international. He discussed the particular features of the Bristol 171 helicopter, which were of interest in view of the earlier remarks made by Wing Commander Brie and Capt. Liptrot. He concentrated chiefly on the problem of vibration. His approach was to analyse the feathering motion of a rotor blade in the form of a Fourier series, the coefficients of which can be associated with the physical and aerodynamic characteristics of the blade. For small tip-speed ratios, only the first harmonic is of importance; with larger tip-speed ratios, the higher harmonics become predominant, resulting in vibration, since the difficulty of supplying a suitable linkage to compensate for these is great. Defining the mean lift coefficient by means of the formula

$$C_{L\ \text{basic}} = \frac{\text{blade lift}}{\frac{1}{2}\rho\omega^2\int_0^R cr^2 dr},$$

the lift coefficient in translational flight can be related to this coefficient, and a limiting value of the tip-speed ratio exists given by

$$\mu_{\text{lim}} = \frac{3}{4}\left[1 - \sqrt{\frac{C_{L\ \text{basic}}}{C_{L\ \max}}}\right],$$

indicating that a high tip-speed ratio is only possible when the basic lift coefficient is small. This can be interpreted as a speed limitation, and when combined with the speed limitation due to critical Mach number

for the aerofoil at the blade tip, a possible operating regime is determined.

Mr. Hafner analysed also the forces acting in the plane of rotation of the rotor blade, and pointed out that the two major forces are those due to profile drag of the blade and the components of the lift vector in the plane of rotation. The reduction in the coning angle of the blade is favourable to drag reduction, and by a suitable choice of design paremeters, it is possible to balance the drag variation due to inflow conditions by the variation in profile drag, the result being a general lowering of the level of vibration.

On the question of controls, Mr. Hafner indicated that there is a very great need for simplification, and asserted that four controls represent the minimum number. The possibility of reducing complexity was illustrated by the fact that there are only twenty-seven moving parts in the rotor control mechanism of the Bristol 171.

On the question of stability, Mr. Hafner felt that stability in forward flight is of much greater importance than hovering stability, and that all that is required in the latter direction is that the helicopter should not be unduly unstable. He spoke at length of the problems of the danger zone referred to by previous speakers, and showed some auto-observer records of descent made in the Bristol 171, which indicated the degree of safety of this aircraft. He closed with some remarks on the question of capital and maintenance costs. He said that these could be reduced by means of good design and that it had been possible for all wearing parts on his machine to be designed for a life of 7,500 hours without great sacrifice in weight.

The last lecturer was Mr. J. Shapiro, who spoke about the Cierva Air Horse. This machine, which is remarkable in many respects, is based on the principle of three lifting rotors. In view of the apparent complication and possible high structure weight of the Air Horse, Mr. Shapiro was faced with the somewhat difficult task of stating its merits which, he claimed, include powerful control in roll and pitch independent of total lift, static stability, dynamic stability in hovering and forward flight, low vibration, ground stability, simple access and, perhaps most important, insensitivity to the position of the centre of gravity when fully loaded. Although these are very desirable, it is difficult to see how the trebling of lifting units and their component parts can have anything other than an adverse effect on the maintenance and utilization of the machine. Since the flying characteristics of the machine have not yet been publicized, it is also difficult to say whether this type of lay-out will achieve all the claims made for it; but as Mr. Shapiro pointed out, in the absence of quantitative information on the value of the desirable characteristics per hour of maintenance, there is little doubt that many of the adverse criticisms springing to mind may be somewhat unjustified.

The discussion which followed the various speakers was of a high order, and perhaps the most interesting point made was the correlation between the accident rates in the United States and the insurance premiums in England. It seems difficult to appreciate that faulty training or the irresponsibility of pilots in America should adversely affect the insurance rates in Britain. Potential operators in Britain are somewhat concerned over this matter—apart from the fact that at the present time they have no British aircraft to operate. The use of helicopters for crop dusting was referred to in the course of discussion, although no one referred to the success or otherwise of the project. It is possible that much that has been said on this question is wishful thinking, and in the absence of more specific information it would seem that much development is required before success in this field is attained.

HENRY ROBERTS

CONTROL OF EQUILIBRIUM IN THE FLYING INSECT

THE higher Diptera, comprising such insects as the house-fly, the blow-flies and the hover-flies, have remarkable powers of controlled flight. The studies of F. S. J. Hollick[1] on the aerodynamics of dipterous flight showed that these insects are inherently stable in pitch, alterations in attitude being corrected automatically by a change in the amplitude of the wing beat. There is some suggestion also of inherent stability in the rolling plane, but nothing to indicate stability in yaw. In general aerodynamical terms, the fly probably shows what is known as 'spiral instability'. The lower Diptera, such as the gnats and daddy-long-legs, have long thin abdomens, which must increase their inherent stability. Inherent stability, however, is a definite hindrance to the making of rapid turns. In the higher forms the abdomen becomes short, and aids to flight in the form of organs of equilibrium become more efficient.

G. Fraenkel and J. W. S. Pringle[2] suggested that such organs of equilibrium are to be found in the oscillating halteres, the modified hind wings of Diptera, which they supposed to act as alternating gyroscopes. Consequently, if the insect is rotated out of the plane of their vibration, lateral shearing forces will be set up in the cuticle at the base and will stimulate the numerous campaniform sense organs that occur there. In ignorance, apparently, of these suggestions, J. Nageotte[3,4] also put forward the hypothesis that flying Diptera control their equilibrium by the perception of the gyroscopic strains in the halteres.

J. W. S. Pringle[5] has now presented a detailed study of the gyroscopic mechanism of the halteres. Dynamical analysis of the oscillating system shows that when the fly as a whole is not rotating, the only forces acting on the basal region of the haltere are the primary torques about the main hinge. When it is rotated in any plane not that of the oscillation, gyroscopic torques are set up at the base of the haltere about an axis at right angles to the plane of oscillation. Physical considerations render it improbable that these gyroscopic torques in the halteres will afford useful information with regard to pitching and rolling rotations. It is only in the yawing plane that the sense organs are likely to give exact information. Flash-photographs of the fly deprived of its halteres confirm that it is, in fact, in that state of spiral instability which is to be expected if there is inadequate stabilization in the yawing plane.

A re-examination of the sense organs at the base of the haltere, and oscillographic records of impulses in the haltere nerve while the haltere is in a state of natural oscillation, provide good support for these conclusions. When there is no rotation of the body of the fly, impulses are recorded which probably result from excitation of the sense organs of the 'scapal plates' and the 'Hicks papillæ' by the primary forces of oscillation. These organs seem to be excited

only when the oscillation has reached its maximum. Perhaps they provide a means of limiting the amplitude of oscillation. But when the body of the fly with its halteres oscillating is rotated in yaw or roll, the pattern of impulses in the haltere nerve changes—probably as the result of the campaniform sensilla of the 'basal plate' being excited by the gyroscopic forces. These sense organs have a much higher sensitivity.

Diptera and other insects have campaniform and chordotonal sensilla around the base of their wings. These will presumably detect strains in the wing, and Pringle writes, "one can imagine an evolutionary process, involving a gradual reduction of the wing area and increase of the wing mass, in which the effect of the inertia forces gradually became more important than the aerodynamic forces".

[1] Hollick, F. S. J., *Phil. Trans. Roy. Soc.*, B, **230**, 356 (1940).
[2] Fraenkel, G., and Pringle, J. W. S., *Nature*, **141**, 919 (1938).
[3] Yagcotte, J., *C.R. Acad. Sci., Paris*, **215**, 509 (1942).
[4] Yagcotte, J., *Arch. Zoo. exp. gén.*, **83**, Notes et Rev. **99** (1944).
[5] Pringle, J. W. S., *Phil. Trans. Roy. Soc.*, B, **233**, 347 (1948).

LOCATION OF THUNDERSTORMS BY RADIO

THE study of atmospheric disturbances in radio reception began at or before the time when electromagnetic waves were being applied to practical communication; and from the beginning of the present century, various investigators were exploring the possibility of using radio methods for forecasting the arrival of thunderstorm conditions. For more than twenty years, the radio direction-finder with cathode-ray tube indication, first described by R. A. Watson-Watt and J. F. Herd[1], has been used in the study of the direction of arrival of atmospherics. By the use of a number of such direction-finding stations suitably situated, simultaneous observations can be made on individual atmospherics, and from the bearings obtained the source of the disturbance can be determined. Such a storm-location network has been built up by the Meteorological Office in the British Isles during the past few years, and the regular daily information obtained therefrom has for a long time formed a substantial contribution to the knowledge used in weather forecasting. The general organisation and arrangement of this 'Sferics' service, as it is called, have been described by C. V. Ockenden[2]; and in a paper read before Section A of the British Association at Dundee, a general review of the present and possible future techniques for the location of thunderstorms by radio was given by R. L. Smith-Rose[3].

To meet the demands of the meteorologist for radio direction-finding equipment of the greatest reliability and accuracy, an improved form of the instrument was developed at the National Physical Laboratory, and has been described by F. Adcock and C. Clarke[4]. The equipment follows the same basic principles described by Watson-Watt and his colleagues, using a pair of crossed-loop receiving aerials connected to twin balanced amplifiers, the outputs from which are connected to the two pairs of plates of the cathode-ray tube. The arrival of an atmospheric causes a line or narrow ellipse to be traced on the screen of this tube in a direction corresponding to that of the source of disturbance at which the atmospheric originated. Various modern improvements in radio and electronic techniques have been incorporated in the present instruments to secure greater reliability, and ease and accuracy of observation. A tube with a long after-glow fluorescent screen is used to enable the observer to make accurate readings on flashes of very short duration. In addition, a brilliance modulator is provided, by means of which only flashes with amplitudes greater than a predetermined value are shown on the tube. This allows the observer to concentrate on the more important flashes. The direction of the disturbances can either be read visually with the aid of a scale and cursor on the tube, or the traces may be photographed as required. In this manner, a thunderstorm area can be located with a high degree of accuracy at ranges up to about 2,500 km.

Following the experimental development described above, the apparatus now in use by the Meteorological Office at four stations in the British Isles has been made by the Plessey Co., Ltd., Ilford, which has given brief details of the sets in a recent Press notice. The receivers operate on a frequency of 12·5 kc./s. (wave-length 24,000 m.), this being the region of the radio spectrum in which the maximum energy is radiated by a lightning discharge, and also where there is the least likelihood of disturbance from radio transmitting stations. Three observing stations, in Cornwall, Fifeshire and Northern Ireland, are controlled from the fourth at Dunstable, which is the central forecasting station and communication centre of the Meteorological Office. Observations are made twelve times daily, and the resulting information is broadcast over the teleprinter network and by radio to enable aircraft pilots to avoid storm areas, and thus reduce the risk of accidents. The information is also of great importance to the synoptic meteorologist in the preparation and study of daily weather charts.

[1] Watson-Watt, R. A., and Herd, J. F., *J. Inst. Elec. Eng.*, **64**, 611 (1926).
[2] Ockenden, C. V., *Met. Mag.*, **76**, 898 (1947).
[3] Smith-Rose, R. L., *Advancement of Science*, **5**, 149 (1948).
[4] Adcock, F., and Clarke, C., *J. Inst. Elec. Eng.*, **94**, part 3, 118 (1947).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, January 8

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 3 p.m.—Sir F. Ewart Smith: "Industrial Research and its Relation to Design and Production".

Monday, January 10

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—"How Radar is Used in Navigation" (Sound Films with Introduction by Mr. R. F. Hansford).

TEXTILE INSTITUTE, OLDHAM BRANCH (at the Technical College, Ascroft Street, Oldham), at 7.30 p.m.—Mr. Higgins: "Plastics for Textiles".

Tuesday, January 11

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 10.15 a.m.—Conference on "Drying".

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1.10 p.m.—Dr. Philip E. Vernon: "The Structure of Practical Abilities".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. R. G. Lienhardt: "Totemism among the Western Dinka".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENTS and RADIO SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Scientific Papers.

INSTITUTION OF NAVAL ARCHITECTS (joint meeting with the INSTITUTE OF MARINE ENGINEERS, at 85–88 The Minories, London, E.C.3), at 5.30 p.m.—Messrs. J. Rhodes, T. H. Arnold and J. R. Rait: "Methods of Non-Destructive Testing of Large Marine Forgings and Castings".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Capt. J. W. Josselyn: "Weather Forecasting at Sea" (Science and Marine Navigation, 2).

CONWAY DISCUSSION CIRCLE (at Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Dr. Olaf Stapledon and Prof. Hyman Levy: "Marxism and Intellectual Freedom".*

INSTITUTION OF THE RUBBER INDUSTRY, BURTON-ON-TRENT SECTION (at the Education Offices, Guild Street, Burton-on-Trent), at 7 p.m.—Mr. H. C. Harrison: "The Extrusion of Rubber".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.30 p.m.—Mr. G. P. L. Williams: "Sources of Information relating to Instruments".

ROYAL SOCIETY OF MEDICINE (joint meeting with the BRITISH PSYCHOLOGICAL SOCIETY, at 1 Wimpole Street, London, W.1), at 8 p.m.—Discussion on "Tensions affecting International Understanding" (to be opened by Dr. Otto Klineberg).

Wednesday, January 12

SOCIETY FOR APPLIED BACTERIOLOGY (at the Medical Society of London, 11 Chandos Street, London, W.1), at 10.15 a.m.—Winter Meeting; with the SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL OF THE FOOD GROUP, at 2.15 p.m.—Scientific Papers.

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. F. Bell: "Distribution of Gaseous Fuel".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. F. T. Barwell and Mr. A. A. Milne: "The Measurement of Kinetic Boundary Friction".

ROYAL METEOROLOGICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 6 p.m.—Sir George Simpson, F.R.S.: "Atmospheric Electricity during the last 50 Years".*

INSTITUTION OF THE RUBBER INDUSTRY, WEST OF ENGLAND SECTION (at the George Hotel, Trowbridge), at 7.45 p.m.—Mr. J. M. Lowe: "Rubber Injection Moulding".

TEXTILE INSTITUTE, MACCLESFIELD, LEEK AND DISTRICT SECTION (at Kings School, Macclesfield), at 8 p.m.—Mr. G. R. Moxon: "The Linking of Science and Craftsmanship in Textile Dyeing and Printing".

Thursday, January 13

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. Macdonald Critchley: "The Medical and Psychological Aspects of Electric Shock, and some of the Nervous Complications".

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. C. Whalley: "Microanalysis in the Oil and Colour Industries".

CHEMICAL SOCIETY, SOCIETY OF CHEMICAL INDUSTRY, and the ROYAL INSTITUTE OF CHEMISTRY, EDINBURGH AND EAST OF SCOTLAND SECTIONS (at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. T. R. Bolam: "Amphipathic Behaviour in Colloid Systems".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Miss Agnes Lothian: "London and Pharmacy in the Seventeenth Century".

Friday, January 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (in the Chemistry Department, King's College, Newcastle-upon-Tyne), at 5 p.m.—Dr. R. Spence: "Chemistry and Atomic Energy" (Bedson Club Lecture).

PHYSICAL SOCIETY (in the large Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Scientific Papers.

ELECTRICAL ASSOCIATION FOR WOMEN (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Miss Dorothy Taylor: "Canada's Electricity—Policy, Peaks, Personnel" (Third Caroline Haslett Trust Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Discussion on "Screw Threads and Loaded Projections".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. Glassman: "Some Theoretical Considerations of Azo-Pigment Chemistry".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (joint meeting with the NORTH-WESTERN ASSOCIATION of the INSTITUTION OF CIVIL ENGINEERS, at the College of Technology, Manchester), at 7 p.m.—Mr. K. W. Mautner: "Recent Developments of Pre-Stressed Concrete Structures".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MATHEMATICS (mainly for National Certificate and Trade courses), and a LECTURER IN MECHANICAL ENGINEERING (mainly for production engineering work), at the Coventry Technical College—The Director of Education, Council House, Coventry (January 15).

LECTURER IN CHEMISTRY AND PHYSICS in the Department of Engineering and Science, Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, 77 George Street, Oxford (January 15).

SENIOR ASSISTANT IN CHEMISTRY, and a LECTURER IN CHEMISTRY in the Chemistry and Biology Department—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (January 15).

LECTURER (man or woman) IN BIOLOGY, including some Degree work—The Warden, Goldsmiths' College, New Cross, London, S.E.14 (January 15).

PROFESSOR OF ZOOLOGY in the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (January 18).

LECTURER (Grade II) IN PHYSIOLOGY—The Secretary and Registrar, The University, Bristol (January 22).

SENIOR LECTURER (Grade I) IN THE DEPARTMENT OF SOCIAL SCIENCE—The Registrar, The University, Liverpool (January 24).

AERODYNAMICISTS (unestablished, in Senior Scientific Officer, Scientific Officer, Senior Experimental Officer, and Experimental Officer grades) at Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.428/48A (January 29).

RESEARCH OFFICER (Rheologist) IN THE C.S.I.R. BUILDING RESEARCH LABORATORY, Melbourne—The Chief Scientific Liaison Officer, Commonwealth of Australia, Africa House, Kingsway, London, W.C.2, quoting No. 2023 (January 29).

RESEARCH OFFICER IN THE C.S.I.R. DIVISION OF INDUSTRIAL CHEMISTRY, Melbourne—The Chief Scientific Liaison Officer, Commonwealth of Australia, Africa House, Kingsway, London, W.C.2, quoting No. 2062 (January 29).

ENTOMOLOGISTS (Junior Professional Officers) IN THE DIVISION OF ENTOMOLOGY, Department of Agriculture, Southern Rhodesia Government—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (January 29).

READER IN ANIMAL HUSBANDRY, and a LECTURER IN CHEMISTRY, at Makerere College, Uganda—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (January 31).

TUTOR or ASSISTANT TUTOR IN BIOCHEMISTRY or PHYSIOLOGY—The Principal, Somerville College, Oxford (January 31).

ASSISTANT AGRICULTURAL INSTRUCTOR (man) at the Somerset Farm Institute, Cannington, Bridgwater—The Chief Education Officer, Belmont Estate, Trull Road, Taunton (January 31).

FORESTRY OFFICER—The Clerk of the Bucks County Council, County Hall, Aylesbury, Bucks (February 7).

READERSHIP IN CHEMISTRY at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 8).

POSTDOCTORATE FELLOWSHIPS for research in Pure Chemistry and Physics—The Chief Scientific Liaison Officer, National Research Council of Canada, Africa House, Kingsway, London, W.C.2 (February 10).

LECTURER (Grade I or Grade II) IN PHYSICS—The Registrar, The University, Reading (February 14).

UNIVERSITY LECTURER IN ECONOMIC STATISTICS—The Secretary of Faculties, University Registry, Oxford (February 14).

LECTURER IN CHEMISTRY in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (Sydney, February 28).

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in various Government Departments throughout Great Britain—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2351.

EXPERIMENTAL and ASSISTANT EXPERIMENTAL OFFICERS in the Ministry of Supply Division of Atomic Energy (Production), at Springfields Factory, Salwick, Preston, to carry out metallurgical experimental work arising from the metallurgical development involved in the production of atomic energy—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington.

CHEMISTS (unestablished) as Experimental Officers in a Ministry of Supply factory near Paisley—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1104/48A.

ASSISTANT ANALYTICAL AND RESEARCH CHEMIST at Stonebridge Park (London), and an ASSISTANT RESEARCH METALLURGIST at Derby—The Scientific Research Manager, Railway Executive, London Midland Region, Euston Station, London, N.W.1.

PHYSICIST to undertake fundamental research in the field of rubber physics for the British Rubber Producers' Research Association—Mr. R. S. Rivlin, Davy Faraday Laboratory, Royal Institution, 21 Albemarle Street, London, W.1.

READERSHIP IN ZOOLOGY AND COMPARATIVE ANATOMY at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1.

SCIENTIFIC ASSISTANT for information service and abstracting journal dealing with milk and milk products—The Commonwealth Bureau of Dairy Science, Shinfield, Reading.

ORGANIC CHEMIST (B.Sc. or equivalent) as Assistant Editor—The General Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

CHEMISTS, PHYSICISTS and METALLURGISTS (in Senior Experimental Officer, Experimental Officer, Assistant Experimental Officer and Senior Scientific Officer or Scientific Officer grades) in the Post Office Engineering Department (Research and Test and Inspection Branches), London and Birmingham—The Engineer-in-Chief's Office, Staff Branch (St. 1), Alder House, Aldersgate Street, London, E.C.1.

BOTANIST (plant breeder) IN THE DEPARTMENT OF AGRICULTURE, Nyasaland—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

GRADUATE METALLURGIST to initiate research on steel foundry problems and to apply results of research to works practice—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

RESEARCH CHEMIST FOR THE DEPARTMENT OF CHEMICAL PATHOLOGY—The Professor of Chemical Pathology, Westminster Medical School, 17 Horseferry Road, London, S.W.1.

ELECTRICAL ENGINEERS in the Electrical Department, Gold Coast Colony—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27324/5.